A DISSERTATION ON

"ROLE OF MR ENTEROGRAPHY IN SMALL BOWEL DISEASES"

Submitted to

THE TAMIL NADU Dr.M.G.R.MEDICAL UNIVERISTY

CHENNAI

In Partial Fulfillment of the Regulations

For the Award of the degree

M.D. DEGREE BRANCH VIII

RADIODIAGNOSIS

MADRAS MEDICAL COLLEGE,

CHENNAI.

APRIL-2015

BONAFIDE CERTIFICATE

This is to certify that **Dr. R.RAJALAKSHMI** has been a post graduate student during the period May 2012 to April 2015 at Barnard Institute of Radiology, Madras Medical College, & Rajiv Gandhi Government General Hospital, Chennai. This Dissertation titled **"ROLE OF MR ENTEROGRAPHY IN SMALL BOWEL DISEASES"** is a bonafide work done by her during the study period and is being submitted to the TamilNadu Dr. M.G.R. Medical University in a partial fulfillment of the M.D. Branch VIII Radiodiagnosis Examination.

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DECLARATION

I **Dr. R.RAJALAKSHMI,** solemnly declare that this dissertation titled **"ROLE OF MR ENTEROGRAPHY IN SMALL BOWEL DISEASES"** is a bonafide work done by me at the Barnard Institute of Radiology, Madras Medical College and Rajiv Gandhi Government General Hospital, under the supervision of Professor K. Vanitha, M.D, D.M.R.D, D.R.M, Director, Barnard Institute of Radiology, and under guidance of Professor K.Malathy. This dissertation is submitted to The Tamil Nadu Dr. M.G.R Medical University, towards partial fulfillment of requirement for the award of M.D. Degree Radiodiagnosis.

Date :

Place: Chennai **Dr.R.RAJALAKSHMI**

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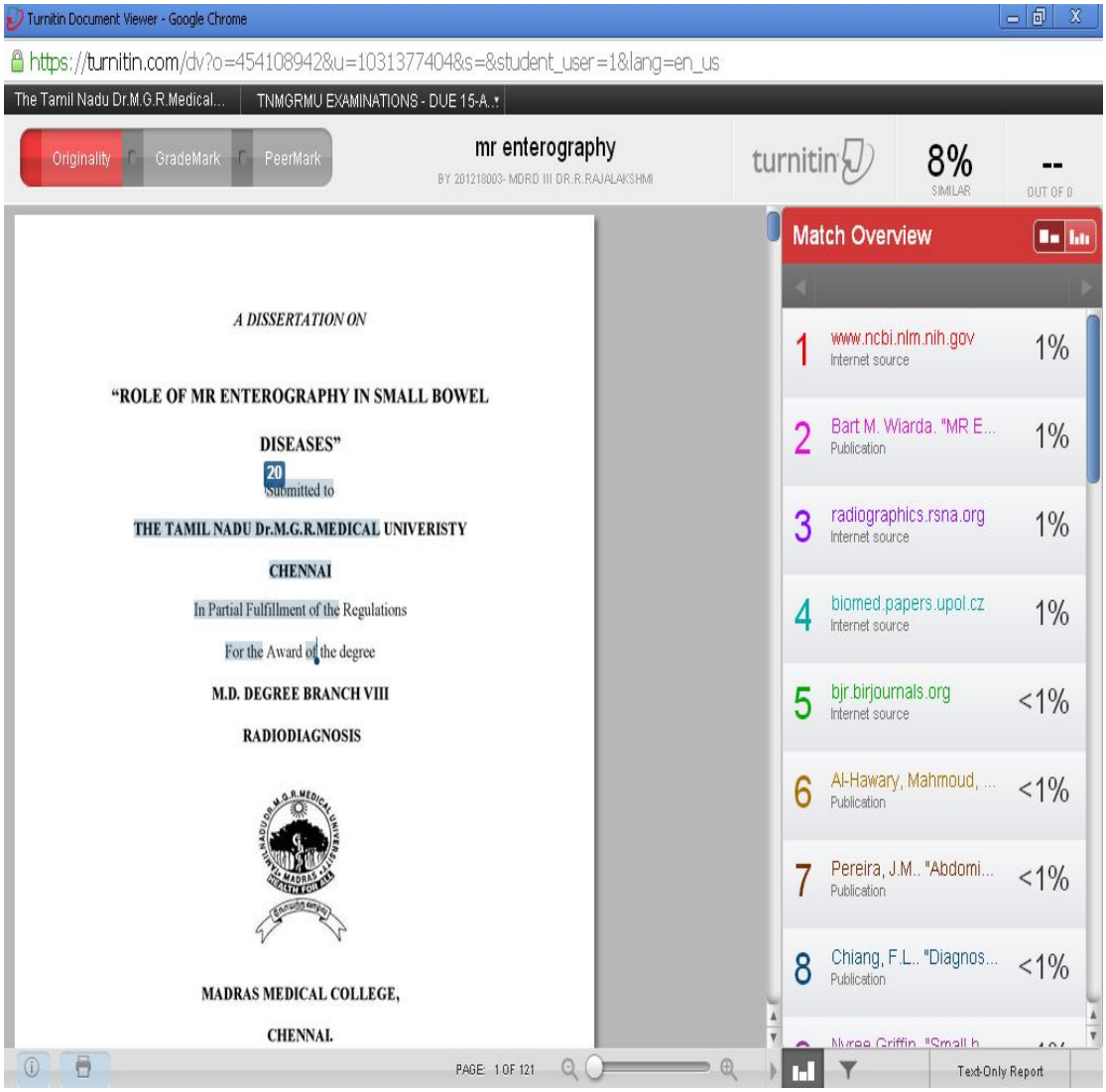
I would be failing in my duty if I don't place on record my sincere thanks to those patients who in spite of their sufferings extended their fullest co-operation.

Dr.R.RAJALAKSHMI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CERTIFICATE OF APPROVAL

To
Dr. R. Rajalakshmi,
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Dear Dr. R. Rajalakshmi,

The Institutional Ethics Committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled **"Role of MR Enterography in small bowel diseases"** No.16062014

The following members of Ethics Committee were present in the meeting held on 03.06.2014 conducted at Madras Medical College, Chennai-3.

1.	Dr. C. Rajendran, M.D.	-- Chairperson
2.	Dr. R. Vimala, M.D., Dean, MMC, Ch-3.	-- Deputy Chair Person
3.	Prof. Kalaiselvi, MD., Vice-Principal, MMC, Ch-3	-- Member
4.	Prof. Nandhini, M.D. Inst. of Pharmacology, MMC, Ch-3.	-- Member
5.	Dr. G. Muralidharan, Director Incharge , Inst. of Surgery	-- Member
6.	Prof. Md Ali, MD., DM., Prof & HOD of MGE, MMC, Ch-3.	-- Member
7.	Prof. Ramadevi, Director i/c, Biochemistry, MMC,Ch-3.	-- Member
8.	Prof. Saraswathy, MD., Director, Pathology, MMC, Ch-3.	-- Member
9.	Prof. Tito, Director, i/c. Inst. of Internal Medicine, MMC	-- Member
10.	Thiru. Rameshkumar, Administrative Officer	-- Lay Person
11.	Thiru. S. Govindasamy, BABL, High Court, Chennai-1.	-- Lawyer
12.	Tmt. Arnold Saulina, MA MSW	-- Social Scientist

We approve the proposal to be conducted in its presented form.

Sd/Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

10/6/14

Member Secretary, Ethics Committee
Vice-Principal
Madras Medical College
Chennai-600 003.

CONTENTS

ABBREVIATIONS

CT	Computed Tomography
MRI	Magnetic Resonance Imaging
USG	Ultrasonogram
HPE	Histopathological Examination
IV	Intravenous
k/c	known case
SBFT	Small bowel follow through
DJ	Duodenojejunal
n	number of cases
IBD	Inflammatory bowel disease
CD	Cohn’s disease
TB	Tuberculosis
OGIB	Obscure Gastrointestinal bleeding
PET	Positron emission tomography

ABSTRACT

TITLE:

ROLE OF MR ENTEROGRAPHY IN SMALL BOWEL DISEASES

Presenting Author: DR.R.RAJALAKSHMI

POST GRADUATE

Co- authors: PROF.DR.K.MALATHI

Name of institution: BARNARD INSTITUTE OF RADIOLOGY,

MADRAS MEDICAL COLLEGE, CHENNAI

AIM OF THE STUDY:

The purpose of this study was to evaluate benefits of MR enterography in diagnosing and characterizing small bowel disease; Correlation of MR enterography findings with Histopathological reports and endoscopy findings; To assess the sensitivity and specificity of MR enterography in diagnosing small bowel disease.

METHOD OF STUDY

Minimum 6 hrs fasting prior to the study; Metoclopromide tablet 20mg to promote gastric emptying; 1mg iv buscopan is administered just prior to the study to minimize movement artifact from peristalsis. Polyethylene glycol (PEG LEC) solution is prepared in 1.5 liters of water; Patient is instructed to drink the solution gradually for one hour for even distension of the entire small bowel and imaged on 1.5 tesla MRI using abdomen coil in supine position & instructed for breathing instructions.

RESULTS:

Among 50 patients small bowel pathology is detected in 26 patients (52%) & no significant abnormalities in24 (48%) patients.

Sensitivity- 92.30% & specificity-91.66% in diagnosing small bowel diseases.

CONCLUSION:

Cross-sectional imaging techniques are playing an increasing role in the evaluation of suspected small-bowel disorders, & growing awareness of the risks of radiation exposure has prompted the exploration of alternative imaging techniques.

Advantages of MRI include lack of ionizing radiation, ability to provide dynamic information regarding bowel distention, motility, improved soft-tissue contrast, and a relatively safe intravenous contrast agent profile.

KEY WORDS:

Enterography, Enteroclysis, Intestinal tuberculosis, Crohn’s, Small bowel,

INTRODUCTION

The small bowel imaging is difficult and challenging because of its positioning, length, and motility. For many years, the most common radiologic modality for evaluating small bowel diseases are conventional small bowel follow through. Barium studies and endoscopy are the basic modalities in diagnosing small bowel diseases in their early stages with endoscopic guided biopsy and histopathological verification. But these studies did not provide extramural involvement of the disease and time consuming, involves radiation, and become tedious in performing the study in every patient with clinical suspicious of small bowel disease.

Therefore there came the evolution of cross sectional imaging with CT in small bowel at most institutions due to its widespread availability, low cost and higher spatial and temporal resolution. With the development of multislice CT, imaging larger volume at faster speed and multiplanar reconstruction after the procedure makes CT a more convenient procedure for examining small bowel diseases. But the main disadvantage of CT is it is based on ionizing radiation hence the most preferable non ionizing modality MRI brought up into small bowel imaging for diagnosing and for follow up.

It has been reported in various studies that CT used for imaging crohns disease exposes the patient to high radiation doses. A recent study stated that “CT accounts for up to 84.7% of the cumulative radiation in patients and that 15.5% of patients with Crohn disease received doses of more than 75 mSv.” (1).

This has to be considered as patients with Crohns disease as they already have an increased risk for developing gastrointestinal cancer.

As a result MR imaging methods developed for imaging small bowel diseases with advent of fast sequences like HASTE, Tru FISP. These sequences can be performed without artifact from peristalsis. Thus MR imaging of small bowel disease allows the imaging of both intra- and extra luminal disease and the complication of the disease without ionizing radiation and the risks associated with it. Even subtle disease manifestations may be detected when adequate distention of the small bowel is achieved.

There are two techniques MR enteroclysis and MR enterography. Enteroclysis requires the placement of nasojejunal tube under fluoroscopic guidance and large volume of oral contrast is administered through the tube.

MR enterography patient is asked to drink the oral contrast for a particular length of time to get adequate distension of the bowel.

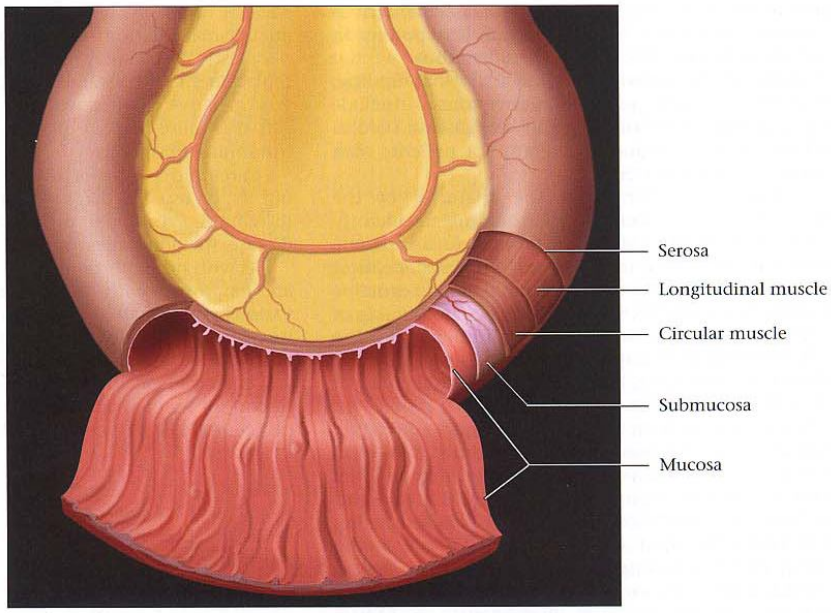
Recent study done by Massaelli.G et. al, 2008 stated that “there is no significant difference between MR enteroclysis and MR enterography in the detection of small bowel diseases” (2).

But the patients discomfort is very less in enterography compared to enteroclysis and patients acceptance highly favors MR enterography and many of the recent literature supports this fact.

REVIEW OF LITERATURE

Small Intestine – Anatomy and Normal Appearances

The small intestine is a tubular structure measuring approximately 6m in length. The duodenum and jejunum constitutes approximately 40% of its length and the ileum contributes approximately 60% of its length and small bowel extends from the DJ flexure to the ileocaecal valve. DJ flexure is located by ligament of Treitz



The main function of small bowel is to receive and digest nutrients from the stomach and deliver the undigested residue to the large bowel.

Small bowel loops are attached to the posterior abdominal wall by the small bowel mesentry which is broad fans shaped peritoneum fold.

Root of mesentry is obliquely positioned extending from DJ flexure to right lower quadrant at ileoceacal junction. Jejunal loops are in the left upper and lower quadrant and ileal loops in the right lower quadrant.

Small intestinal loops are normally in the partially collapsed state and when their maximal lumen diameter is less than 3cm it is considered as normal.

Circular and spiral shaped configuration in the jejunal loops are valvulae convenientes and it is about 2mm thickness. It is seen in the proximal ileum and about 1mm thickness and absent in the terminal ileum characterizing featureless ileal loops.

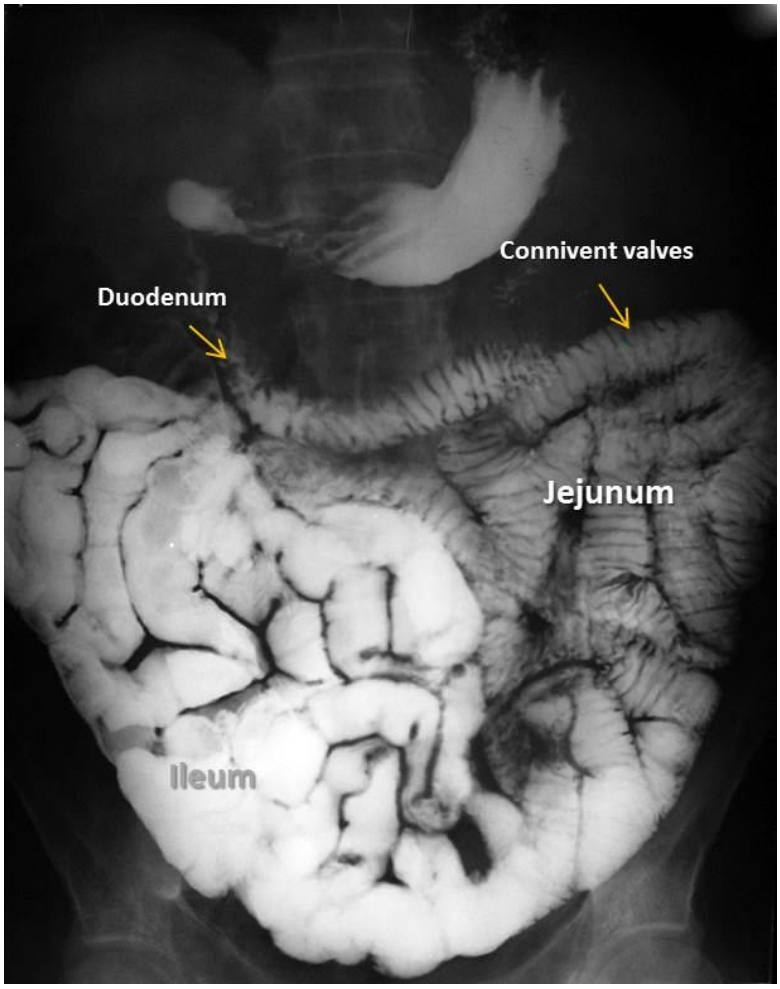
VARIOUS DIAGNOSTIC MODALITIES

PLAIN RADIOGRAPHY

Plain radiographs remain the most commonly performed study in imaging world because of its availability, low cost and non- invasiveness. Perforation, bowel obstruction, pneumatosis intestanilis, foreign bodies remain the indication for plain radiograph in the small bowel investigations.

SMALL BOWEL FOLLOW THOUGH

Until the 1990's for diagnosing small bowel diseases, the main modality available in radiology is small bowel follow through. Large volume of lower density barium is administered and succession of overhead films is used to monitor the barium progress. The appearance of barium in ceacum becomes an indication for flourosopy to demonstrate the terminal ileum.



For double contrast method, effervescent agents are given that release gas in the small intestine and can be used to give double-contrast views.

Multiple views are available during the examination. Compression films are usually needed to visualize overlapping small bowel loops, to diagnose fixated loops.

The mucosal surface is better depicted in conventional barium studies and it also provides indirect information on disease extension inside and outside of the small bowel wall.

The main disadvantage of barium follow-through is

- Time consuming both for patients and the radiology department;
- Use of ionizing radiation hence has the study is restricted particularly in children and pregnant women.
- No major useful information given about extraluminal disease.

Because of these factors barium study is being replaced by other modalities and cross sectional imaging.

CONVENTIONAL ENTEROCLYSIS

The main principle is to introduce the nasojejunal tube and to place its tip at duodenal jejunal flexure. Usually it is done under fluoroscopy.

Then to administer the barium through the nasojejunal tube either manually or with the help of automatic pump. About 250 ml of barium sulphate is given followed by 0.5% methyl cellulose solution for a total of about 1500-2000ml. Complete adequate distension of bowel loops can be obtained with this method.

Sensitivity of conventional enteroclysis is 93.1% and specificity is 96.9% and the study is found accurate in detecting mucosal lesions of small bowel disease, and also the study helps in the detection of small bowel obstruction

Disadvantages of conventional enteroclysis

- Nasojejunal intubation is highly discomfortable to the patients.
- Radiation dose to the young patients
- As like in the barium follow though very limited information about the extraluminal disease.
- Overlapping bowel loops may lead to diagnostic difficulty.
- Possibility of complications of intubation.

Advantages of conventional enteroclysis

- By introducing barium beyond gastric outflow regulations by pylorus barium can be directly introduced into the small bowel as rapidly as indicated.
- Lumen distension is controlled by the rate of the infusion.
- The examination is completed within 20 to 30 minutes which is very shorter when compared with barium follow though.

ULTRASOUND

Ultrasound is a modality without radiation, with high accessibility and at low cost, but small bowel imaging using ultrasound is difficult. 3.5–5 MHz transducer is used for abdomen and thereby small bowel ultrasound. Compression has to be given to displace bowel gas Target pattern and pseudo kidney pattern corresponds to thickened bowel wall.

LIMITATIONS OF ULTRASOUND

- The field of view is limited,
- The technique is operator-dependent.
- Less suitable technique for the follow-up(3).

Ultrasound does not currently play a role in the diagnostic work-up in most of the small bowel diseases.

CT

With the advent of the multislice CT cross sectional imaging has almost replaced the conventional studies as CT has very fast scan rate, able to image the whole abdomen within few minutes, post processing techniques with multiplanar reconstruction, less discomfort to the patient.

As the bowel loops are usually collapsed differerntiating bowel wall thickening from collapsed segments is difficult with CT without enteric contrast and iv contrast (4,5).

CT ENTEROCLYSIS

NUCLEAR MEDICINE

Nuclear medicine is a useful adjunctive imaging technique used to detect IBD. Leucocyte scintigraphy and FDG-PET used in diagnosing suspicious inflammatory bowel disease and also helpful in differentiating between active and inactive disease.

Meta analysis study done to compare accuracy in detecting lesions found that no significant difference between scintigraphy, CT and MRI. (6). The drawbacks of leucocyte scintigraphy are the lower detection rate of extramural disease and the use of ionizing radiation (7). No data are available to suggest that leucocyte scintigraphy is indicated in patients with OGIB.

PET

FDG (fluoro-2-deoxy-D-glucose) PET imaging is based on the detection of abnormal glucose metabolism hence it is a functional imaging modality. As FDG concentrates in the active inflammation, it can be used in detecting diseases that involve active inflammation.

But PET currently is not used in Crohn's disease as not all are active segments in crohns disease and showed increased FDG-uptake (8). The role of PET/CT in patients with OGIB has been evaluated only in patients with small bowel neoplasms(9).

ENDOSCOPY

Apart from the widely used ileocolonoscopy, which only allows for visualization of the terminal ileum, two other techniques are available that result in the visualization of a large part of the small bowel.

ILECOLONOSCOPY

After the routine colonoscopy, the terminal ileum is intubated and approximately 30 cm of the terminal ileum is visualized using this technique.

BALLOON-ASSISTED ENDOSCOPY

It consists of an endoscope with one or several balloons attached By inflating and deflating the balloon around the scope, almost the entire small bowel can be visualized. Tissue sampling for histological examination and the treatment of fibrotic strictures can be done with this technique. (10,11).

The visualization achieved with this technique is comparable to standard enteroscopy; therefore, the technique can be considered the reference standard for imaging the small bowel.

CAPSULE ENDOSCOPY

This technique consists of a large capsule with a camera inside that takes two images of the bowel lumen every second for 8 hours (12).

Several studies have reported promising results for capsule endoscopy in patients with Crohn's disease and OGIB (13). In a meta-analysis, capsule endoscopy was superior to other techniques.

CAPSULE ENDOSCOPY

Only one study (14) compared capsule endoscopy with MR enterography in a small patient group with Crohn's disease and OGIB without using a reference standard. This study revealed that capsule endoscopy diagnosed significantly more inflammatory lesions in the proximal and middle portion of the small bowel than MR enterography in patients with Crohn's disease, and that capsule endoscopy was also superior to MR enterography in patients with OGIB.

So far, no head-to-head comparison studies have been performed concerning MR enteroclysis, which has important advantages over other imaging techniques than MRI, such as an unlimited multi-planar field of view, reproducibility, and no ionizing radiation.

PUSH ENTEROSCOPY

Push enteroscopy is mainly for visualizing jejunal loops. The scopy is introduced upto DJ flexure and introduced further like colonoscopy technique. Overall yield of diagnosis with push enteroscope is 53%.

SONDE ENTEROSCOPY

Sonde enteroscopy has a very long (290cm) , thin (5mm), flexible endoscope wire and it can passed into the small bowel with the help of peristalsis. So it takes many hours (nearly 8 hours) to visualize the entire small bowel. This procedure is cumbersome and obsolete now.

INTRAOPERATIVE ENTEROSCOPY

It is usually performed at the laprotomy procedure or through the enterostomy sites. It requires the instruments like colonoscope, push enteroscope, and video processor. It is done in patients with occult gi bleeding and source could not be identified with any modality.

MRI

MRI is an imaging modality with high contrast resolution of soft tissue without using ionizing radiation and also having multiplanar imaging. Due to the development of shorter scanning techniques, e.g.

single shot techniques, the entire small bowel can be visualized without artifacts caused by small bowel peristalsis and respiration movements.

MRI can evaluate features like bowel wall thickness, wall enhancement, bowel wall oedema, ulceration, perimural infiltration, and lymph node evaluation, contrast enhancement, adhesions, strictures, fistula, perianal fistulas, abscess, bowel obstruction, all of which are important features to be observed in small bowel disease and MRI is a single stop to visualize all these findings.(15,16).

As most of the small-bowel diseases manifest earlier in life and persists as a long term condition, patient suffering from small bowel disease has to undergo multiple radiological/ endoscopic interventions to see for any progression of the disease or response to therapy and to look for any complications. MR enterography is a boon to these kind of patients as it has no radiation risk and non invasive procedure.

ADVANTAGES

- Most important is MRI do not use ionizing radiation.
- Tissue contrast is superior in MRI than that of CT.
- Intravenous contrast material for MR imaging has a good safety profile and MR enterography with contrast can be used in patients in whom

CT with i.v contrast cannot be taken like patients with allergic reactions to CT iv contrast and patients with elevated serum creatinine.

- Gadolinium i.v contrast is not necessarily as lots of abnormalities can be detected with MRI without the need of iv contrast. This is great benefit to pregnant patients, patients with renal failure and low GFR and patients with possibility of risk of developing nephrogenic systemic fibrosis.

LIMITATIONS OF MR IMAGING

- Cost of the study,
- Claustrophobia
- Spatial and temporal resolution is comparatively lower in MRI than CT.
- Some patients may difficulty in breath hold.

MR ENTEROCLYSIS

- MR enteroclysis is a technique in which nasoenteric tube is placed at DJ flexure using fluoroscopy before MR enteroclysis is begun.
- Then mannitol 3% solution is administered though the tube either via manual injection or automated pump or MR compatible infusion device. Then the patient should be immediately transferred to MRI

room for scanning or mannitol infusion can also be done in MRI scanning room.

- Contrast is infused at a rate of 80 mL/min and flow rate is adjusted according to the bowel distension.
- First sequence to be applied is coronal balanced SSFP images as a scout image and to assess the adequacy of bowel distension and to see whether contrast has reached ileoceacal junction.
- Then after giving breathing instructions axial and coronal sequences are applied alternatively.
- Then contrast-enhanced sequences also performed similarly.

MR ENTEROGRAPHY VS MR ENTEROCLYSIS

MR enterography is a technique in which large volume of oral contrast is given per oral for a particular period of time instead of nasojejunal intubation as in MR enteroclysis.

In a study done by negaard et al and frokjaer et al patients acceptance is favoring MR enterography than enteroclysis (17,18).

Another prospective study done by negaard et al showed that enterography and enteroclysis has similar sensitivity in diagnosing active

inflammation in crohns. The study done by Schreyer et al also shown the same sensitivity for MR enterogrpahy and enteroclysis. (19,20).

Masselli et al in his prospective study done at 2008 said that mucosal abnormalities are better shown in MR enteroclysis than MR enterography. (2).

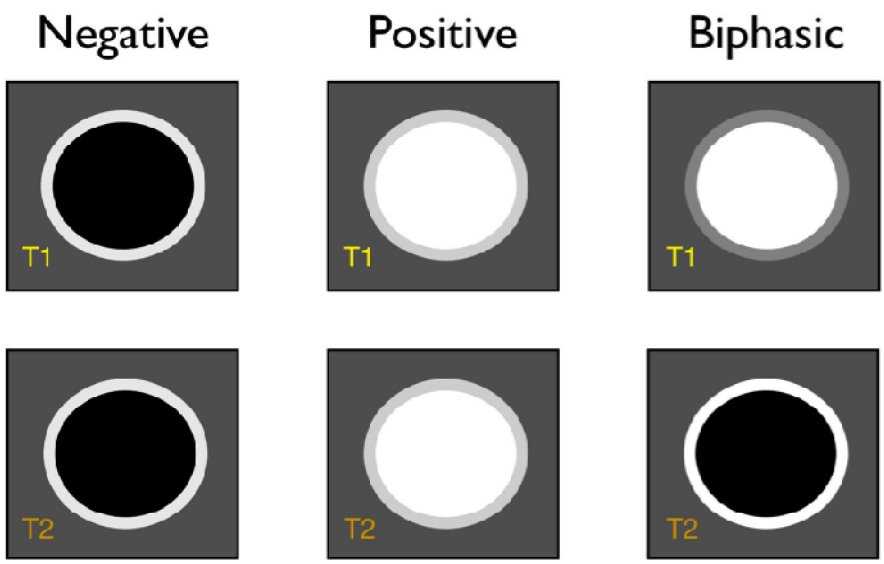
But masseli in his same study said that better distension of bowel may be in enteroclysis but that could not be translated as better diagnostic accuracy(2).

Many other articles revealed the fact that patient acceptance is far better in MR enterography than MR enteroclysis.

ORAL CONTRAST AGENTS

There are several oral contrast agents that can be used for MR imaging. Three categories based on signal onT1- and T2-weighted images:

- High signal intensity on both T1 &T2- Positive contrast agents,
- Low signal intensity on both T1 &T2 - Negative contrast agents,
- High signal intensity on T2 and low signal on T1 images- Biphasic contrast agents.



Most of the available oral contrast agents are biphasic category. Mannitol and PEG are the oral contrast agents most commonly used.

Filder et al, desmond at al evaluated different contrast agents, like water, mannitol, polyethylene glycol, osmotic and nonosmotic agents and found no significant difference between the agents in imaging values but each has unique charectistics and limitations (21,22,23).

Lots of algorithm suggested for the protocol of oral contrast ingestion but the basic view is to large quantity of oral contrast solution to be taken during one hour.

Studies done by boraschi et al, faber et al, herrmann et al, laghi et al mainly concentrated on the preferred oral contrast agents and mainly on

negative contrast agents like oral magnetic particles, perfluorooctyl bromide, ferumoxide. (24–29).

These study results are bowel wall inflammation usually causes high signal intensity on T2 weighted images, if the bowel lumen is dark in T2 with negative oral contrast solution, there will be a great contrast between dark bowel lumen and bright wall inflammation. Interbowel loop abscess also better picked up with negative contrast agents.

Study done by laghi et al and reiber et al mainly on the positive contrast agents. They are ferrous ions, manganese ions, gadolinium chelates, (27,28). Karantanas et al studied bluberry juice as positive oral contrast. Other food items like milk, vegetable oil, green tea, can be used as enteric contrast agents(29). Contrast between wall thickening and lumen is seen in T1 weighted images but contrast enhancement on T1 images are not well depicted.

PEG SOLUTION AND REGIMEN:

45 mg reconstituted in 1 liter of which the patient takes 1.5-2 l (depending on the patient tolerance) commencing approximately 45-60 min before imaging. The patient takes 1-1.5 l in the first 30 min and then 250 ml every 15 min. Immediately before imaging, the patient has to drink approximately 500 ml of water. This regimen permits the

evaluation of the entire small bowel in slow intestinal transits, and the water administered on the MR table allows for the scanning of the jejunal loops in rapid intestinal transits, where the passage to the colon may result in poor small bowel distension.

This regimen is well tolerated. According to herraiz hidalgo et al there are virtually no adverse effects and less than 5% of their study patients had intestinal discomfort or moderate diarrhea for several hours after the examination.

There are similar results for this PEG regimen and reported in many papers.(30,31,32)

Most important issues regarding oral contrast administration are the volume of contrast and the timing of administration.

There is a wide range of interpersonal variability in transit times, between patients. (with the exception of patients with obstruction).

Using PEG, the average time the column of contrast takes to reach the cecum varies from 20 to 240 min, with an average time of 55---65 min.(31).

RECTAL CONTRAST ADMINISTRATION

Studies done by narin et al and ajaj et al stressed that contrast given per rectum to distend large bowel will be better in lesion detection. Especially in crohns disease combination of enterography with colonography is better imaging technique and it is supported by studies done by Schreyer et al and herrmann et al. (20,26 ,33,34). But colonic abnormalities may be well shown with antegrade filling without rectal contrast need.

PATIENT POSITIONING

Cronin et al done a study in 2008 comparing prone vs supine positioning in patients undergoing MR enterogrpahy, may be imaged in either the supine or the prone position. Separation of small-bowel loops from the pelvis is noted in prone position but it is not necessarily needed. (35).

SPASMOLYTICS AND GASTRIC EMPTYING

Bowel peristalsis causes artifacts in imaging mainly in the gradient echo sequence. HASTE sequence which is a fast heavily T2 weighted sequence is particular for intraluminal flow artifacts due to intraluminal air. Contrast VIBE 3D sequence is also more prone for artifacts due to motion.

Spasmolytics helps in reducing the peristalsis and thereby reducing motion artifacts.

The commonly used spasmolytic is 20 mg intravenous buscopan (hyoscine –N- butylbromide). Contraindication for buscopan like acute angle glaucoma, cardiac arrhythmia should be ruled out.

Some studies revealed that two divided dose of glucagon 0.5 mg initially subcutaneously before starting the study and later 0.3 mg intravenously before contrast sequence is applied.

Few studies mentioned 1mg intravenous glucagon just before contrast sequence is applied.

For gastric emptying metaclopramide suspension 10mg suspension is given.

INTRAVENOUS CONTRAST MATERIAL

Study done by Low RN et al showed correlation between gadolinium enhanced sequences and endoscopic findings. In his study he demonstrated contrast enhancement in bowel wall, perienteric hyperenhancement suggests active inflammation in crohn's disease and it is also useful for detecting enhancement in lymphnodes and mass lesions. (36–38).

Dose for gadodiamide is 0.2 mmol/kg and given at the rate of 3ml per second, scanning should start after 45 seconds.

There are many researches ongoing in the field of perfusion imaging for small bowel diseases.

Intravenous contrast is not mandatory for MR enterography and pattern of wall thickening and surrounding inflammation and signal characteristics in T2 weighted images also helps in diagnosing active inflammation. Gadolinium contrast helps in better characterization of the lesion.

Many researches are ongoing to determine the availability and utility of perfusion imaging of the bowel for evaluation of inflammatory bowel disease.

SEQUENCES

Multiple sequences are needed for the study of MR enterography hence limitations of each sequences are compensated.

There is no generalized protocols for MR enterography but the routinely used sequences are T2-weighted sequences like HASTE and balanced SSFP.

HASTE (ULTRA FAST SPIN ECHO SEQUENCE)

HASTE (half Fourier single shot turbo spin echo sequence) sequences are breathing independent T2 weighted sequence.

- Not sensitive to patient motion or respiration hence used in uncooperative patients.
- Susceptibility insensitive
- Not much detailed view of bowel wall.
- These sequences are very much sensitive for motion particularly intraluminal air motion. And produces low signal intensity artifacts within bowel lumen.

BALANCED SSFP

Balanced SSFP images is a gradient sequence and it is a very fast sequence and it is called as TruFisp in Siemens machine and FIESTA (Fast imaging employing steady state acquisition) in GE machine

This sequence has a

- Very high signal to noise ratio and
- Good T2/T1 weighted image contrast.
- Displays fluid homogenously.
- Susceptibility sensitive
- Any motion causes heavy artifacts with signal loss.
- Black boundary artifact is seen.

- Better demonstration of mesenteric vessels and lymphadenopathy than HASTE sequence.

Fat suppression is needed for better depiction of lesion as lesions are hyperintense in T2 weighted sequence and it will be better seen if perienteric fat is suppressed using fat suppression technique (37). Bowel wall is better seen in fat-suppressed TruFisp images than fat-suppressed HASTE images. Fat suppression technique eliminates black boundary artifacts

Contrast- sequence is applied either two- or three-dimensional acquisitions. This sequence has a lengthy volumetric acquisitions, hence blurring may occur due to wall motion.

CINE MRI EVALUATION OF BOWEL –

MR FLUOROSCOPY

- One of the earliest sign in inflammatory bowel disease is decreased peristalsis in the diseased segment of bowel loop.
- Standard MR enterography is based on static imaging.
- There is a new technique of real time cine MRI with this bowel peristalsis can be visualized.
- The sequence used for cine MRI is thick slab coronal balanced steady state sequence with 10mm thickness of abdomen and continuously imaged for peristaltic evaluation.
- This is also used to check whether the oral contrast have reached the ileoceacal junction.

Study done by waldehrr et al compared cine MRI and conventional MR enterography in 40 patients who are known case of crohns disease.(57). The findings are described as areas of abnormal motility increased or decreased peristalsis when compared with normal bowel.

Results of the study are

- Cine MRI find more number of abnormal segments than standard static MR enterography.
- The author confidently depicts that bowel dysmotility is earliest sign of inflammatory bowel disease.
- Limitation of this study is there is no histological or endoscopic correlation of cine imaging findings

DIAGNOSTIC QUALITY OF BOWEL DISTENSION

Rakesh sinha et al at 2013 done a study on the impact of divided oral contrast ingestion on bowel distension and quality of images in MR enterography (58).

As adequate distension is imminent for the successful study patient compliance, timing of imaging, amount of contrast ingested is important.

THREE GRADES IN MR ENTEROGRPAHY:

- **Grade 3:** All the bowel loops are well distended. -confident diagnostic study.
- **Grade 2:** Few bowel loops are less distended and remaining are well distended and opacified, - diagnostic study
- **Grade 1:** Most of the bowel loops are unopacified hence non diagnostic study.

For grading measurement should be done at axial TruFi images with fat suppression. Fat suppression is needed to eliminate black boundary artifact. Measurements should be taken at normal bowel segments as there may be alterations due to bowel mural wall thickness in diseased portions. Three measurements are taken at ileum, jejunum and ceacum and average of three values should be taken.

Results of this study are

- Bowel diameter more than 1.95cm are in the grade 3 quality and best for diagnostic interpretation.
- Most of the patients have grade 3 distension with divided dose preparation.

- Suboptimal distension with poorer image quality in standard dose preparation.
- Increasing bowel diameter and diagnostic image quality has strong positive correlation.

MRE PERFORMANCE CHARACTERISTICS

There are many studies that depicts the performance characteristics of MR enterography.

Study done by **Foriano et al** clearly stated that CT and MR enterography had similar efficacy in identifying disease localization, bowel wall thickening, enhancement identifying fistula and lymphnodes(59).

- In this study, MRE is more sensitive in identifying stricture than CTE and MRE having slightly more sensitivity for bowel wall enhancement than CTE,
- Sensitivities and specificities of MR enterography for small intestinal manifestations in crohns disease were similar to other reported studies with 0.88 (0.78-0.99, CI 95%) sensitivity and 0.88 (0.68-1.0, CI 95%) specificity.
- Enteroenteric fistula identification was almost similar between CTE and MRE (0.04 vs 0.02; p=0.08), respectively.
- This study concluded that both CT and MR enterography are highly effective modalities in assessing ileocolonic Crohn's disease and having similar accuracy.

Another study done by **Jensen et al** (60) compared image quality and also disease evaluation in CT and MR Enterography.

- He stated that CT has a better image quality because of little motion artifact due to fast acquisition.
- Inter-observer agreement for disease evaluation, was high for CT and moderate for MR enterography.
- In this study it was also found that disease evaluation of small bowel is both observer and modality dependent.
- Both techniques had comparable diagnostic yields inspite of the difference.
- He concluded that MR enterography is an acceptable alternative to CT enterography.

Ilangovan et al (61) stated in his study that CT enterography compared with MR enterography had good superior spatial and temporal resolution, and CT had fast single breath-hold examination.

- He also mentions that CT is cheaper and more available than MRI enterography, shorter examination times for CT.

- But he states that contrast resolution is superior in MRI and demonstrating fistulae is better in MRI than CT.
- Gadolinium-based intravenous contrast used for MR examination is safer than the iodinated contrast used for CT.

Meta-analysis study done by **Horsthuis et al (6) and Siddiki et al (46) "** Both small bowel CT and MRI had similar diagnostic performance; Of course, the radiation exposure with CT is a disadvantage compared with MRI"

A cohort study done by **Masselli et al** recently compared MR enterography and MR enteroclysis in Crohn's disease. (2).

- This study showed that bowel distention and mucosal bowel abnormality better depicted in MR enteroclysis.
- Detection of luminal narrowing, fistulae are similar in both MR enterography and enteroclysis.
- MR enteroclysis may be preferable modality for Crohn's disease evaluation but MR enterography is an acceptable alternative in those unable to tolerate nasojejunal intubation.

COMPARISON OF MRI WITH OTHER IMAGING MODALITIES:

The MRI protocol most frequently compared with other modalities has been MR enterography. A number of recent prospective studies have demonstrated MR enterography to be at least comparable to other imaging modalities for detection of small bowel disease in Crohn's patients.

A study done recently by **Francis et al** compares contrast-enhanced MR and CT enterography in Crohn's disease. This study found that for detection of subtle small bowel inflammatory changes MRI is better than CT. (62).

Comparison of MR enterography with fluoroscopic barium small bowel series done in a study conducted at 2005 by **Greenberg et al** (63).

- Patients (30 subjects) who are known case of crohns disease underwent both MR enterography and small bowel series on different days and comparison between these modalities done.
- The study results are 60% of study both study has concordant results. Remaining 40% of subjects with discordant results,

SBFT demonstrated additional findings in 12% of cases, and MRI found additional information in 27% of cases by demonstrating active inflammation. But no histological or endoscopic comparison was included in this study.

A study conducted by **Kim et al** in 2009 compared 4 modalities MR enterography and CT enterography, barium SBFT and ileocolonoscopy (64) in each patients who are known cases of crohns disease (30 subjects).

- Both CT and MRI has better accuracy in detection of extramural complications of crohns like fistulae, sinus tracts, abscesses than barium SBFT.
- Both CT and MRI also demonstrated more segments of active bowel wall inflammation proximal to the terminal ileum than SBFT.

Another study done in 2009 by **Fidler et al** compared MR and CT enterography in patients with suspicious of crohns disease and they used ileocolonoscopic as reference standard. The sensitivity in detecting active small bowel inflammation obtained by MR enterography is 90.5% and by CT enterography is 95.2% and it is almost similar and comparable. (21).

Wireless capsule endoscopy (WCE) is a minimally invasive technique for small bowel evaluation(65). The patient has to swallow the capsule endoscope and it is propelled by peristalsis and captures images of the small bowel which is stored in a recorder. It provides small bowel endoluminal information. Major advantages is it can detect subtle mucosal abnormalities. Limitations are it cannot be given in patients with stricture and extraluminal lesion cannot be visualized.

- Only limited studies available for comparison of MR enterography and wireless capsule endoscopy. One study compared MR enteroclysis with wireless capsule endoscopy in patients with suspected small bowel disease with a sample size of 15 patients. In this study there is no correlation with HPE.
- This study showed that capsule endoscopy shows more number of lesions in jejunum than MR enterography and no difference in lesion detection in the region of terminal ileum.

MRI shows extraluminal complications very well in all the patients.

In a large meta analysis study done at may 2010 by **Ingrid markova et al (71)** which compares various modalities like CT, CT enteroclysis, CT enterography, USG, contrast enhanced ultrasound, MR enterography, MR enteroclysis, small bowel follow through, conventional enteroclysis, various endoscopic techniques like ileocolonoscopy, push enteroscopy, sonde enteroscopy, wireless capsule endoscopy, double balloon enteroscopy, intraoperative enteroscopy. This study submitted its results as follows

- Small bowel follow through has only secondary role in imaging.
- For children ultrasound is the preferred modality
- Conventional enteroclysis is replaced by the cross sectional imaging.
- CT and MR enterography is preferred by most authors and they strictly not needed the intubation procedure under fluoroscopic guidance.

- MRI is found to be more sensitive than CT in diagnosing small bowel inflammatory diseases.
- CT or MR enterography is the preferred modality for follow up examinations
- CT/MR enterography or CT/MR enteroclysis are more sensitive in diagnosing small bowel tumors.
- Wireless capsule endoscopy is the better investigation for detecting mucosal abnormalities in patients with obscure g.i bleeding.

COMPARING ENDOSCOPIC AND RADIOLOGICAL PROCEDURES (MR ENTEROGRAPHY)

RADIOLOGICAL PROCEDURES:

- Minimally invasive to the patients
- It shows entire imaging of the small bowel
- Doesn’t have radiation exposure
- Takes less time to complete the procedure

ENDOSCOPIC METHODS:

- It is invasive and more cumbersome to the patients
- Has the complications of the invasive procedure
- Depends on the doing persons technical skill.
- Takes long time to finish
- Expensive than most of the radiological procedures
- But has advantage of taking biopsy from the lesions visualized.

CT VERSUS MR ENTEROGRAPHY:

CT ENTEROGRAPHY (COMPARED WITH MR ENTEROGRAPHY)

- Technically more robust and easy
- Short examination time
- More accessible
- Higher technical and interpretive reproducibility
- Works better for acute, severe, complex, and emergent cases
- Less expensive
- Causes radiation exposure

MR ENTEROGRAPHY (COMPARED WITH CT ENTEROGRAPHY**)**

- Technically more difficult
- Long examination time
- Less accessible
- Better suited for organ specific and disease specific (e.g. Crohn's disease) evaluation
- May not work well for acute, severe, complex, and emergent cases
- More expensive
- No radiation exposure

NEWER TECHNIQUES:

EMERGING ROLES OF MRI IN INFLAMMATORY DISEASE:

TECHNICAL ADVANCES IN MRI:

- There is a lot of technical advancement in MRI like higher magnetic field, motion artifact reduction techniques, parallel imaging processing, shorter scan times.
- Due to the advent of these there is increased spatial resolution in detection of subtle bowel changes.
- With these developments MRI will become a surveillance tool in small bowel imaging replacing CT and other invasive procedures.
- MR Fluoroscopy and MR Perfusion are the emergent techniques that attracts lot of attention.
- Scoring of disease activity in crohn’s disease also an upcoming area.

DETECTION OF MURAL FIBROSIS:

- The main role of imaging in crohns is differentiating active from inactive disease. For that the detection of mural fibrosis came into play.
- If active inflammatory bowel segment is found in imaging patient has to be started in disease modifying therapy, but if inactive mural fibrosis is detected on imaging it indicates the last irreversible stage of the disease and patient is switched to surgical treatment for resection of the fibrosed segment if needed.
- Mural fibrosis is the collagen deposition in the submucosal and serosal layer and it causes marked luminal narrowing and proximal dilatation of the bowel hence the need of surgical management.
- It is important to differentiate between mural fibrosis and stricture caused by active inflammation. MRI features of mural fibrosis are T2 hypointensity in segment of bowel wall with lack of contrast enhancement.

COMBINATION OF MR ENTEROGRAPHY AND MR COLONOGRAPHY:

- Single protocol that combines both MR enterography and colonography will be very helpful for evaluation of small and large bowel at a single study especially in the patients with crohns disease.
- Study done in 2005 followed a protocol that combined both enterography and colonograhy. In that study done in known case of crohns they gave 1.5 liters of oral contrast and 750ml to 1 liter of enema. They done this study in 20 patients and in another 20 patients they carried out the standard enterography protocol without enema. They compared the study with scopy findings.
- In this study they clearly showed that administration of enema more lesions are found out than standard enterography protocol.
- But the major issue is patient's compliance. Many patients felt uncomfortable and distended. Giving additional rectal contrast is less acceptable by the patients. The study mentioned that distending the large bowel by oral contrast and scanning with delayed time is more preferred and ideal examination.

MRI AS A BIOMARKER FOR THERAPEUTIC RESPONSE:

- Inflammatory bowel disease treatment has been changing by the introduction of molecular pathway targeting therapies. Some of proinflammatory cytokines involved in inflammatory bowel diseases are CTLA-4, CD20, TNF -α, α_4 integrin molecules. (66)

- When patients are refractory to the standard treatment for inflammatory bowel disease these biological agents are considered for treatment and they are found to be more specific treatment. Some of the agents that are in current role are chimeric antibodies, recombinant peptides. These molecules are very costly and having many unique side effects and used only as a last therapeutic approach.

- There is a need of frequent assessment of response at each time administering the biomolecule and MRI is well served as a biological marker for assessing therapeutic response.

- It is highly beneficial for the patients to avoid potential side effects by the biomolecules by an early imaging assessment of treatment response or failure.

NEW SEQUENCES AND TECHNIQUES

DIFFUSION-WEIGHTED MRI

Restricted diffusion in the bowel wall segments signifies active disease. Four retrospective studies based on diffusion weighted sequence conducted and proved this with a variety of reference standards(67).

MOTILITY IMAGING

Fast T2-weighted cine sequences are used for assessing small bowel motility. This can be attained in a single breathhold. Qualitative assessment of bowel motility can be assessed with this imaging. Cine MRI study conducted in a group found more crohns disease cases than compared with standard protocol (68,69).

MAGNETIZATION TRANSFER IMAGING

There was a study which compared magnetization transfer ratio and tissue collagen level in crohns disease, and found to have linear relation between them (70).

MRI SCORES OF DISEASE SEVERITY

If disease severity is given in scores, it will be helpful to compare for the disease progression and response to treatment and also helpful in comparing with other patients. Some of the indices that are in clinical trial for scoring disease activity are HBI, CDEIS, CDAI.

RUTGEERTS SCORE:

A study conducted in 2008, (70) MR enteroclysis and ileocolonoscopy done in patients with suscpicion of disease recurrence with study sample of 30 patients. ***Rutgeerts score*** was obtained. This score ranging from 0 to 3, in which 0 means normal and score of 3 means active disease recurrence. MRI features that gives score of 3 is definite bowel wall thickening, enhancement of the bowel wall, perimural fat, high grade bowel obstruction, fistulas, abscess, T2 signal characteristics.

In this study the results showed good correlation between MRI scoring and ileocolonoscopic findings ($\kappa = 0.67$). This scoring system had good similar results when done with many other radiologists ($\kappa = 0.89$).

MAGNETIC RESONANCE INDEX OF ACTIVITY (MARIA):

Another scoring system developed called magnetic resonance index of activity (MaRIA). MaRIA score was calculated by comparing MRI findings and CDEIS.

"Wall thickness (p = 0.007), relative contrast enhancement (p = 0.01), mural edema (p = 0.02), and ulceration at MRI (p = 0.003) were independent predictors of segmental CDEIS. On the basis of regression model, the authors proposed a simplified MaRIA score per segment: 1.56 × wall thickness in millimeters + 0.02 × relative contrast enhancement + 5 × edema + 10 × ulceration."

Mucosal ulceration is the important component of the MaRIA scoring system. This scoring system has a significant correlation with the segmental CDEIS (r = 0.81, p < 0.001). By adding individual segmental scores total Ma-RIA score was obtained and found to have significant correlation with many of the parameters like total CDEIS score (r = 0.78), HBI (r = 0.56), CRP concentration (r = 0.53).

The same author again(70) conducted the same study in a new group of 48 patients and proved his study values again using same MRI protocol.

CDA SCORE:

Another new scoring system for disease activity is Crohn Disease activity (CDA) score. This score was correlated with histopatlological findings of disease activity. This score also found to have good qualitative scoring of disease activity.

AIM OF THE STUDY

- The purpose of this study was to evaluate benefits of MR enterography in diagnosing and characterizing small bowel disease.

- Correlation of MR enterography findings with Histopathological reports and ileocolonoscopy findings.

- To assess the sensitivity and specificity of MR enterography in diagnosing small bowel disease and to assess sensitivity and specificity in detecting crohn's disease.

METHODOLOGY

STUDY CENTER

The study was done in Barnard Institute of Radiology, Rajiv Gandhi Government General Hospital, Chennai

SAMPLE SIZE: 50 patients

STUDY PERIOD: 6 months (March 2014 to August 2014)

STUDY DESIGN: Prospective observational study

INCLUSION CRITERIA

Patient of any age

Presented with strong clinical suspicious for small bowel disease

Suspected to have partial, low grade small intestinal obstruction,

Suspected to have small intestinal tuberculosis

Suspected to have inflammatory bowel disease,

Patients having unexplained abdominal pain,

Patients having chronic right iliac fossa pain

Patients having history of malabsorption.

Patients having unexplained gastrointestinal bleeding.

EXCLUSION CRITERIA

Patient with general contraindication for MRI

Patient with total bowel obstruction

Patient with acute symptoms

Patient with severe vomiting

Sick patients

Patient who are not given the consent for the study.

These patients are not included in the study group.

MR ENTEROGRAPHY PROTOCOL

Patients who were admitted in the ward who presented with clinical findings and symptoms suggesting of small bowel disease were enrolled in the study. A written informed consent was obtained from the patient before enrolment into the study. The clinical history regarding present history was taken in the prescribed proforma. Other investigations if already done like usg abdomen, CT abdomen findings, scopy findings are noted down.

BOWEL PREPARATION

Patient should be instructed to minimum 6 hrs fasting prior to the study;

Patient can take liquid food like juices at this time.

No laxatives or enema administered prior to the study.

Patient is asked to arrive one and half hour before the examination.

ORAL INGESTION PROTOCOL

DIVIDED DOSE PREPARATION

On arrival at the radiology department, patient was asked to drink 1200-1500 ml PEG solution over 50 min.

Polyethylene glycol (PEG LEC) solution is prepared by dissolving 9 mEQ of PEG with electrolytes & flavoring agents which is commercially available as PEG LEC 70 grams of powder in 1.5 liters of water

The oral contrast material was divided into two portions, and instructed to drink each portion in 25 minutes.

10 mg of oral metoclopromide suspension for promoting gastric emptying is given with the first portion.

To opacify stomach and duodenum just before imaging, patients instructed to have another 200 ml of oral contrast.

Patient is instructed to drink the solution gradually for even distension of the entire small bowel.

One hour after the commencement of oral contrast ingestion patient is imaged on 1.5 Tesla MRI (Magnetom Avanto; Siemens, Erlangen, Germany) using phased array abdomen coil in supine position.

Patient is instructed for breathing instructions.

Before running the sequences 1mg of i.v buscopan is given to minimize movement artifact from peristalsis.

Images are obtained and evaluated.

Results are followed up with clinical follow up and histo pathological findings.

PROTOCOL

SEQUENCE	T2 TruFisp	T2 TruFisp	T2 TruFisp	T2 HASTE	T2 HASTE	T1Flash pre/post Gd
ORIENTATION	coronal	axial	sagital	coronal	axial	coronal
SCAN TIME	20 sec	22 sec	13 sec	30 sec	50 sec	2 min 20 s
SLICES(mm)	24	23	17	24	23	72
THICKNESS(mm)	5	7	7	5	7	2
GAP(mm)	0	7	7	0	7	.4
TR(ms)	3.34	2.83	2.83	124	128	3.52
TE(ms)	1.38	1.2	1.2	93	97	1.16
AVERAGES	1	1	1	1	1	1
MATRIX	192x156	166x156	166x156	218x256	166x156	230x256
FLIP ANGLES	60	70	70	150	150	12
MEASUREMENT	1	1	1	1	1	2

OBSERVATIONS

The studies were carried out on 50 cases with small bowel indications and the following observations are made.

- The total examination time averagely of about 5.0 minutes (within the range of 3.5 to 10 min).

- Most of the patients are comfortable with drinking oral contrast solution and only two patients had minor side effects during drinking. One patient vomited at the end of the drinking oral contrast solution and another patient had a minor diarrhea while drinking the solution. But both patients settled and managed to complete the study.

- In one patient the study could not be completed at first attempt as in that patient contrast material did not reach the terminal ileum as a result of incomplete bowel preparation. After bowel preparation patient was asked to come on another day and study was completed.

- There were no artifacts caused by motion in TruFisp sequence and study interpretation in TruFisp sequence is not affected by motion in any of the patients

- One patient had a susceptibility artifact in TruFisp sequence.

- In three patients, artifacts due to small bowel peristalsis is seen in FLASH 3D T1 contrast sequence but there is no problem in analyzing the bowel wall enhancement in these patients.

- Normal small bowel thickness is 3mm, and if it is exceeded more than 4 mm and it is considered as abnormal.

If there is bowel wall thickening then further analyzing it whether

- circumferential or asymmetrical;
- regular or irregular walls,
- signal characteristics in T2 weighted sequence – hyperintense suggesting active inflammation, hypointensity in T2 suggesting fibrosis,
- length of the involved segment,
- any skip lesions
- associated perienteric inflammation
- fat stranding surrounding the involved segment of bowel
- mesenteric phlegmon
- interloop abscess
- enlarged adjacent lymphnodes
- luminal narrowing in the involved segment.

- Other features like fibrofatty proliferation, enlarged lymph nodes, mesenteric vessel engorgement and ascites also noted down.

- Contrast enhancement of the bowel wall noted; pattern of bowel wall enhancement- homogenous, heterogenous or stratified pattern noted.

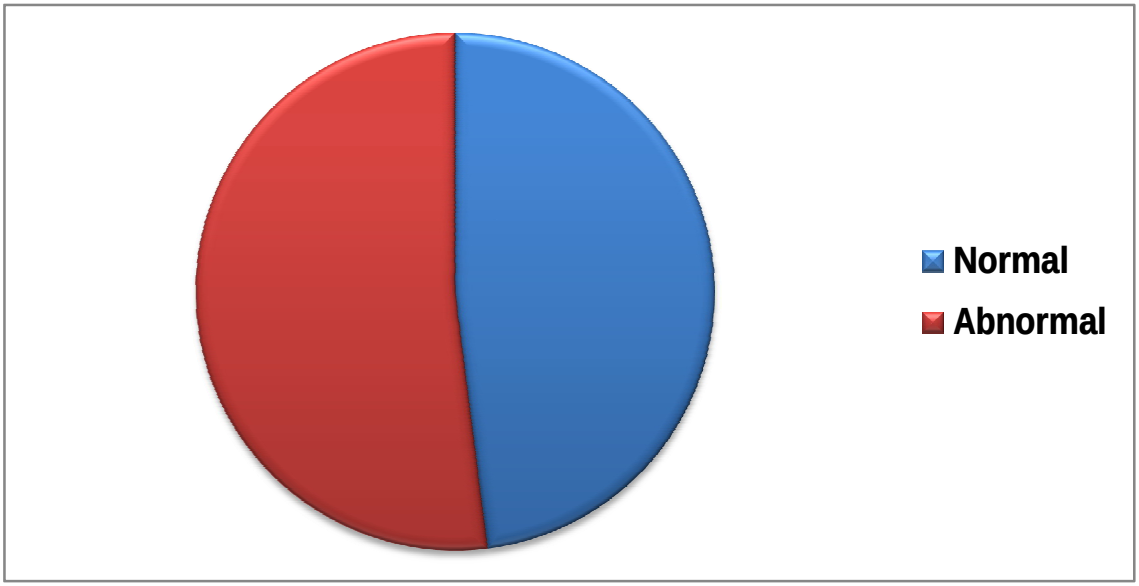
- Complications like enteroenteric fistula, enterocolic fistula, colocolic fistuala, perianal fistula and abscesses also noted.

- Bowel luminal narrowing is graded as
  - Absent
  - Mild – one third decrease in luminal distension
  - Moderate – two third decrease in luminal distension
  - Severe - total obstruction of the small bowel.

RESULTS

TABLE1

Normal	Abnormal	Total
24	26	50
48%	52%	100%



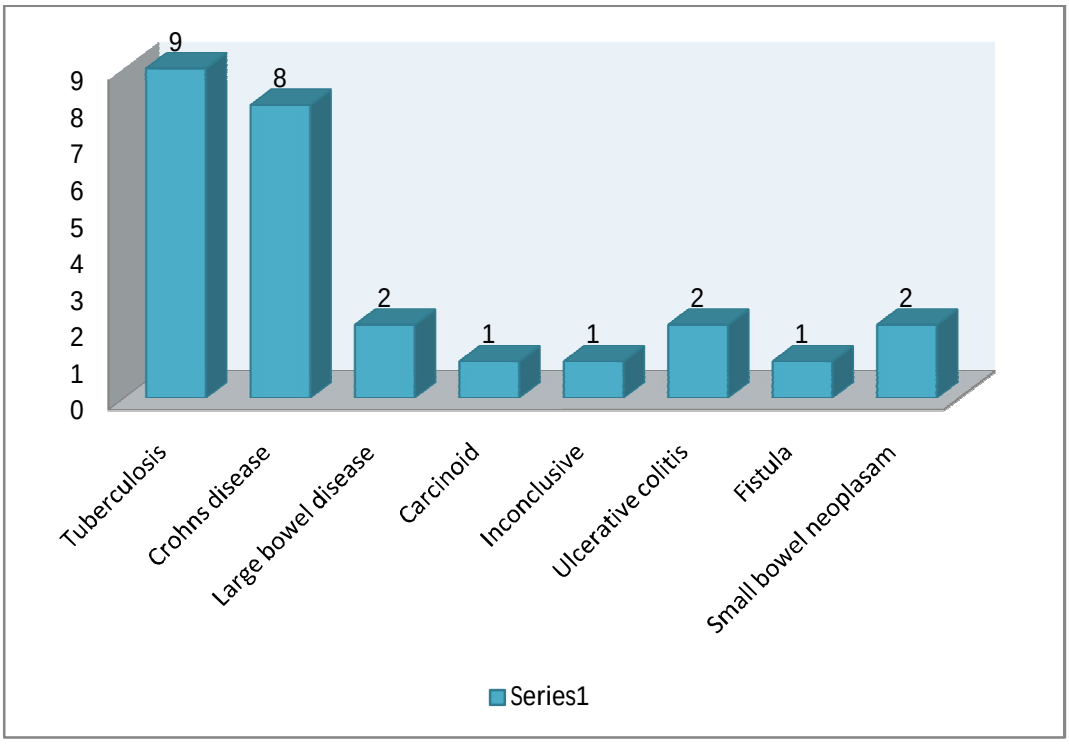
Among 50 total subjects, 24 subjects have normal MR enterographic study and 26 subjects have abnormal MR enterography findings. That is 52% are abnormal and 48% are normal.

TABLE 2

DISEASES AMONG ABNORMAL SUBJECTS

TYPE	NUMBER	PERCENTAGE AMONG TOTAL SUBJECTS
Tuberculosis	9	18%
Crohns disease	8	16%
Large bowel disease	2	4%
Carcinoid	1	2%
Inconclusive	1	2%
Ulcerative colitis	2	4%
Fistula	1	2%
Small bowel neoplasam	2	4%

DISEASES AMONG ABNORMAL SUBJECTS

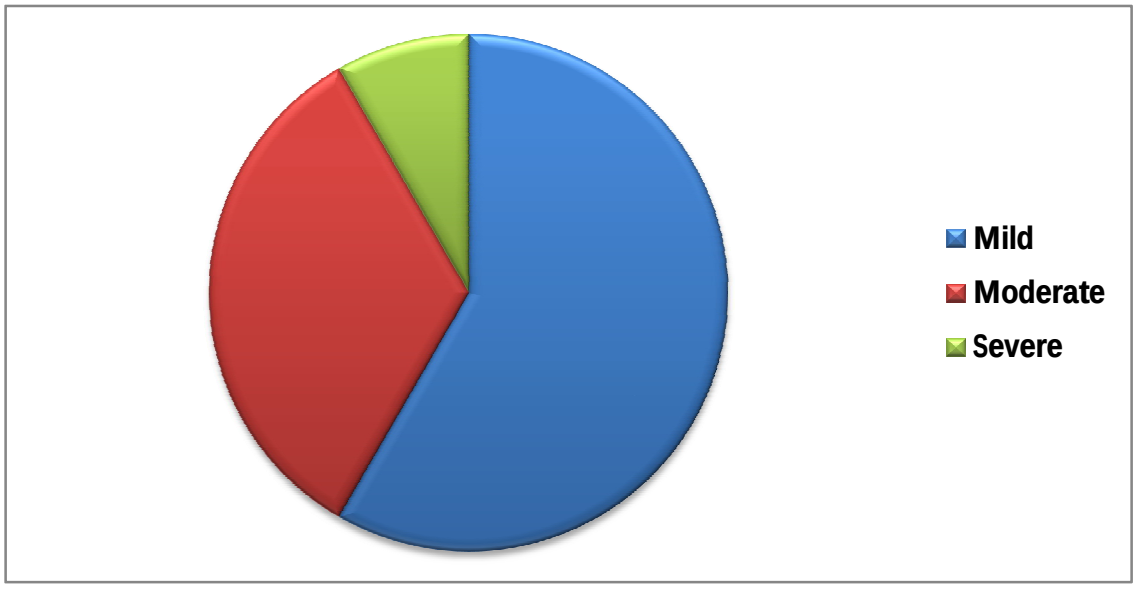


The table and chart explains that among 26 patients having abnormality, diagnosis made in MR enterography are tuberculosis intestine in 9 patients (18% of total subjects), diagnosis of crohn's disease given in 8 patients (16% of total subjects), large bowel disease is found in two patients out of 50 subjects (4% of total subjects) , carcinoid tumour is found in one person (2% of total subjects), inconclusive in one person(2% of total subjects), diagnosis of ulcerative colitis given in two patients (4% of total subjects), fistula is seen in one patient (2% of total subjects), small bowel neoplasm seen in 2 patients (4% of total subjects).

TABLE 3

Small bowel obstruction is present in twelve out of 26 abnormal patients

Mild	Moderate	Severe
7	4	1



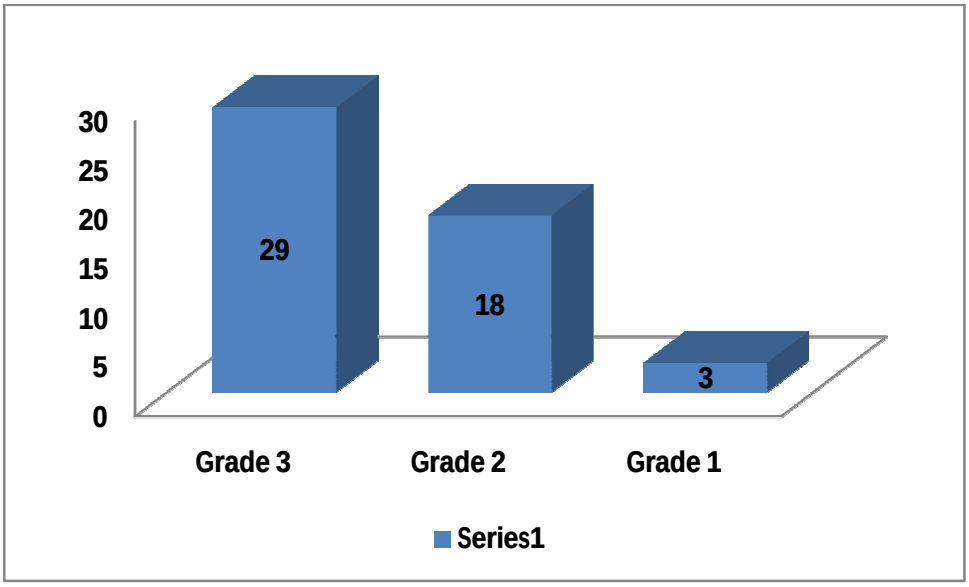
Among them mild obstruction is seen in seven patients (n=7), moderate obstruction is seen in four patients(n=4), and severe obstruction in one patient. (n=1).

TABLE 4

ADEQUACY OF BOWEL DISTENSION GRADING

Grade 3	Grade 2	Grade 1
29	18	3

FIGURE:



Among the 50 patients 29 patients have all of the bowel loops well distended ; 18 patients have most of the bowel loops well distended, few loops are unopacified; In 3 out of 50 patients most of the loops are less distended and less opacified.

TABLE 5

SENSITIVITY AND SPECIFICITY OF MR ENTEROGRAPHY

MRE	HPE		Total
	PRESENT	ABSENT	
POSITIVE	24	2	26
NEGATIVE	2	22	24
TOTAL	26	24	50

SENSITIVITY- 92.30%

SPECIFICITY-91.66%

26 patients who had abnormal findings in MR enterography, on follow up with scopy and HPE findings, MR enterography findings and HPE findings correlated in 24 patients.

In two patients MR enterography showed findings but with negative HPE results. In two patients in whom MR enterography is normal but scopy showed findings with positive HPE results.

TABLE 6

SENSITIVITY AND SPECIFICITY OF MR ENTEROGRAPHY IN DIAGNOSING CROHNS DISEASE

MRE	HPE		Total
	PRESENT	ABSENT	
POSITIVE	7	1	8
NEGATIVE	2	40	42
TOTAL	9	41	50

SENSITIVITY- 77.77%

SPECIFICITY-97.56%

8 among 50 patients are diagnosed as crohn's disease.

Among these 8 patients, seven patients showed correlation with HPE and one patient had negative HPE results.

2 patients out of remaining 42 subjects in whom MR enterography was normal but scopy and HPE findings are crohn's disease.

DISCUSSION

Small bowel pathology is detected in 26 patients (52%) and no significant abnormalities in24 (48%) patients.

ILEOCEACAL TUBERCULOSIS:

Nine patients small bowel wall thickening compatible with ileoceacal tuberculosis.

- Out of these nine patients four patients had bowel wall thickening, lymphnode enlargement and ascities.
- Three patients had bowel wall thickening and lymph node enlargement.
- Two patients had only bowel wall thickening.
- Seven out of nine patients had ceacal involvement.
- Pulled up ceacum is seen in four patients.
- Mesenteric inflammatory changes seen in four patients.
- Peritoneal thickening and nodules seen in one patient.
- Out of these nine patients only two patients had thoracic symptoms and findings.

CROHN'S DISEASE

Small bowel wall abnormalities suggesting crohn's disease is seen in eight patients

- All patients are newly diagnosed.
- Length of the involved segment varies between 2 to 15 cm.
- More than one segment of bowel (skip lesions) seen in two patients.
- Low to intermediate grade of small bowel obstruction is seen in three of the crohn's patients.
- Entero-cutaneous fistula is seen in one patient.
- Perianal fistulas detected in 2 patients.

LARGE BOWEL PATHOLOGY

Two patients with lower g.i bleeding had normal small bowel findings and found to have pathology in the large bowel.

- One patient had subtle asymmetric wall thickening in the rectum and later proved to be rectal adenocarcinoma with HPE.
- Another patient had proliferative ceacal growth and proved to be ceacal adenocarcinoma with HPE.

ULCERATIVE COLITIS

Two patients had features consistent with ulcerative colitis.

Both patients have uniform rectal wall thickening with contrast enhancement of the wall with no perienteric inflammation of fat.

Lesions are limited to the rectum with no small bowel lesions found in both patients.

SMALL BOWEL NEOPLASM

Small bowel neoplasm is found out in this study in two patients both of them have vague long term abdominal pain. One in the duodenum and another in the jejuna loop. Both the patients underwent surgery.

- Duodenal lesion HPE came to be adenoma and
- Jejunal lesion HPE is lymphoma.

One patient had an infiltrating carcinoid of terminal ileum.

One patient had inconclusive findings on MR enterography and patient was on follow –up.

SMALL BOWEL OBSTRUCTION

Small bowel obstruction is present in twelve out of 26 patients with mild in seven patients (*n*=7), moderate in four patients(*n=4*), and severe in one patient. (*n*=1).

One patient in whom the enterography was found to be normal has perforation of duodenum one month after the study and got operated for that.

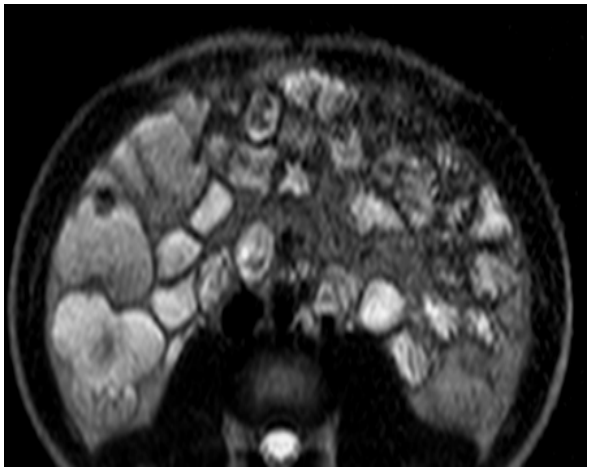
Therapeutic strategy is altered in many patients who underwent MR enterography.

HASTE SEQUENCE

CORONAL

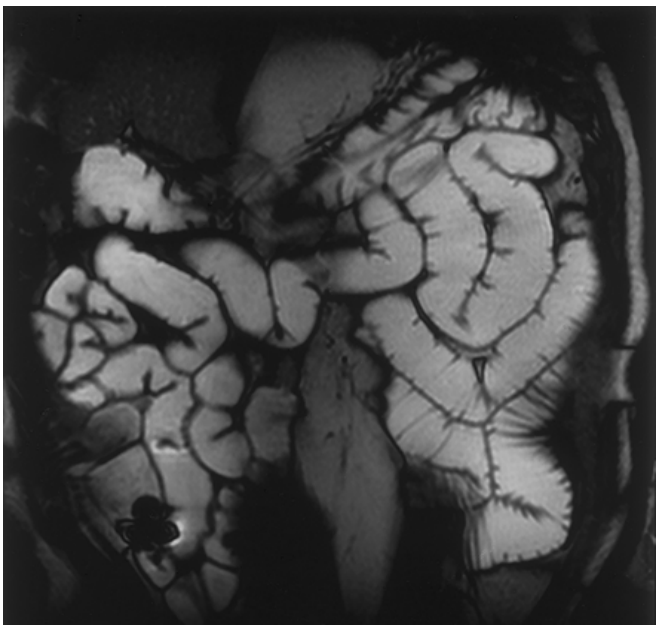
- Fast sequence
- Sensitive to intraluminal flow voids
- Poor evaluation of mesentery

AXIAL



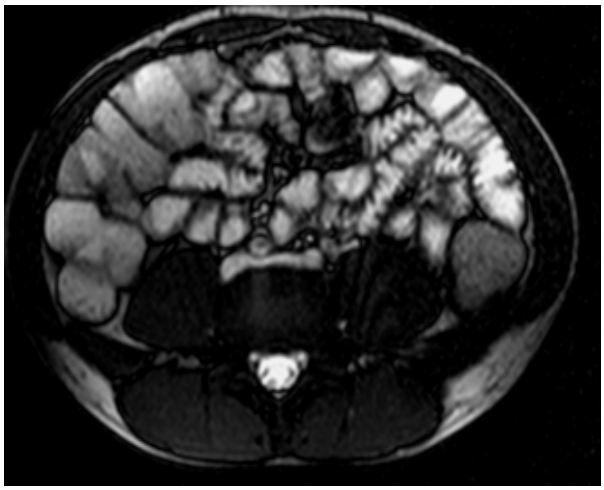
TruFISP SEQUENCE

CORONAL

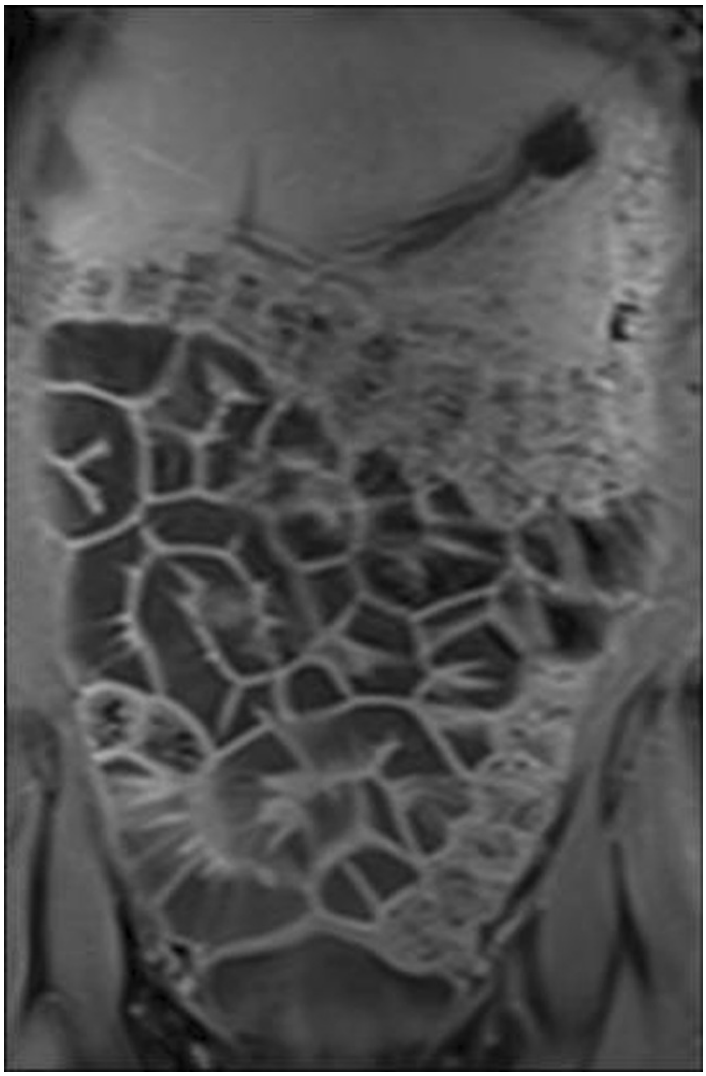


- Fast
- High contrast between small bowel lumen and bowel walls
- Homogeneous endoluminal opacification
- Good mesenteric anatomy (LAN, comb sign, vessels)
- Susceptibility artifacts from intraluminal air
- Chemical shift artifacts – black boundary

AXIAL



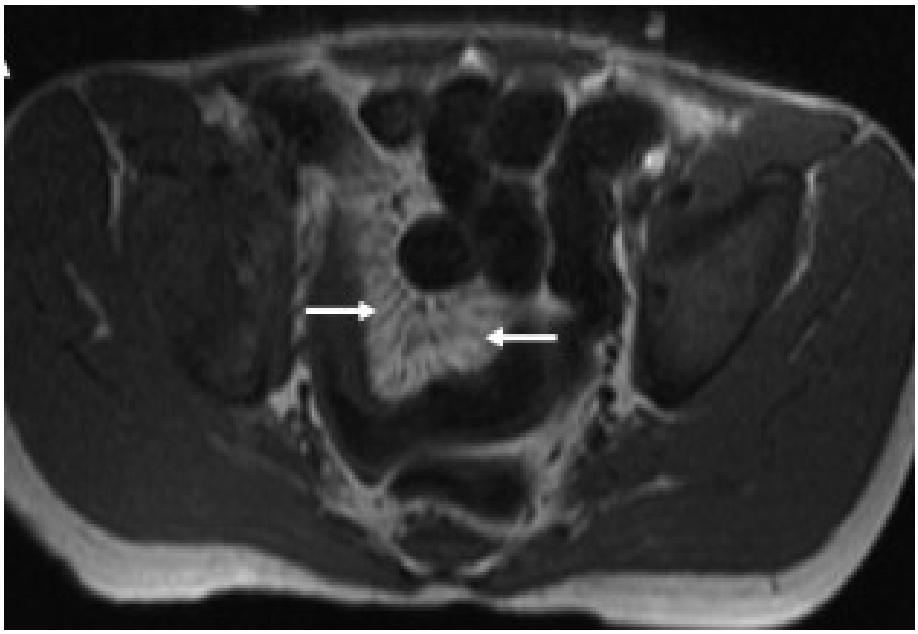
CORONAL T1 FAT SATURATED POST CONTRAST IMAGE



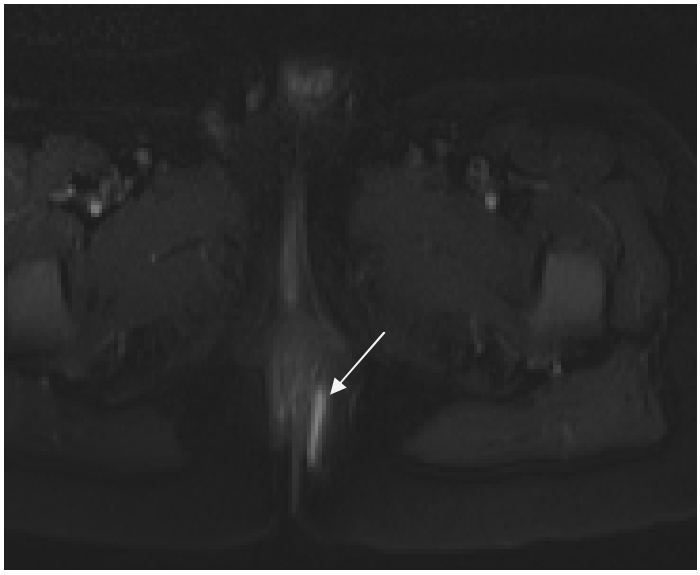
Coronal T1 fat-saturated post-contrast image: normal bowel wall shows mild homogeneous enhancement

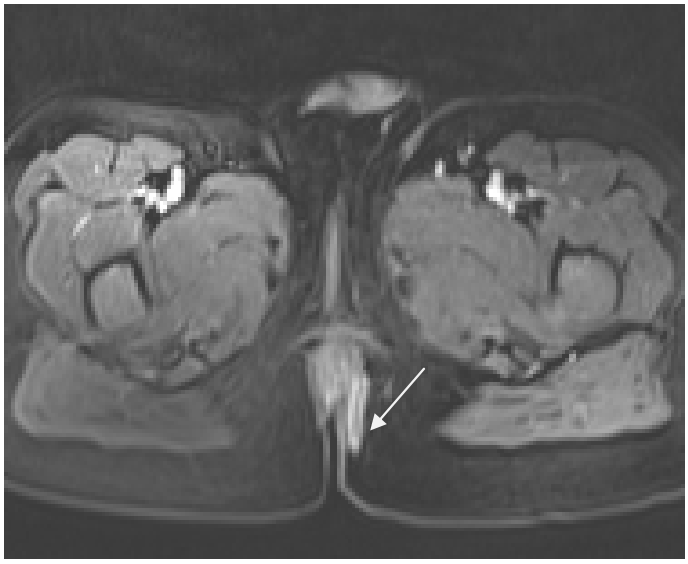
- 3 D spoiled gradient echo sequence
- Sensitive to motion artifact
- Bowel peristalsis is reduced by prior administration of spasmolytic

COMB'S SIGN



PERIANAL CROHN'S DISEASE

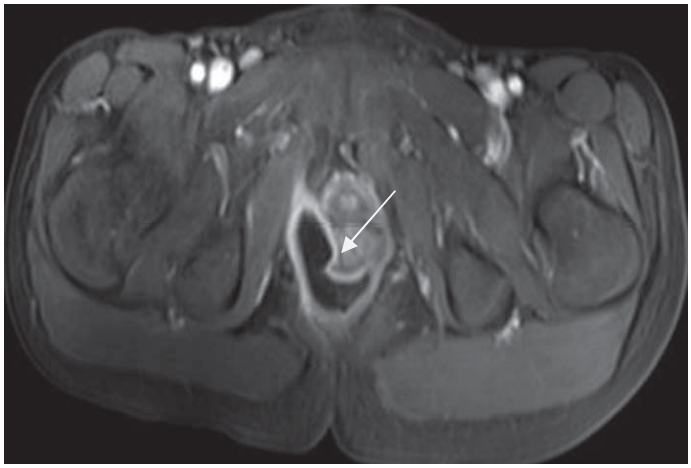




Intersphincteric Fistula in patient with crohn's disease.

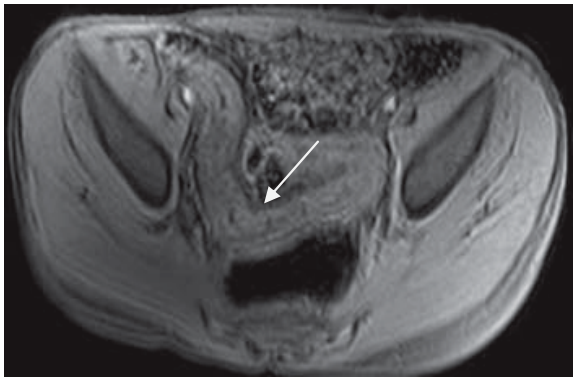
CASE 1 CROHN'S DISEASE WITH PERIANAL FISTULA AND ABSCESS

Coronal contrast enhanced T1 weighted MR shows terminal ileum showing increased wall thickening and contrast enhancement- terminal ileitis suggestive of crohn's disease.

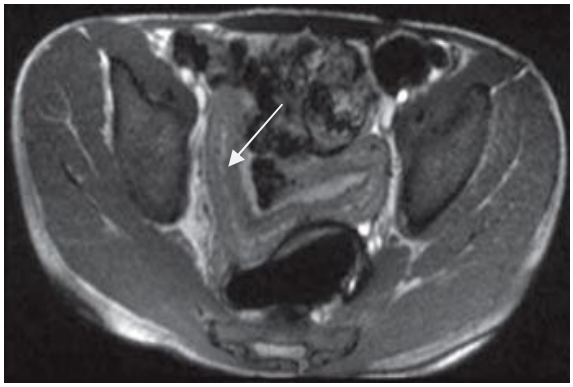


Axial contrast enhanced T1 weighted MR image in the same patient shows peripherally enhancing abscess with surrounding fat stranding and transsphincteric fistula.

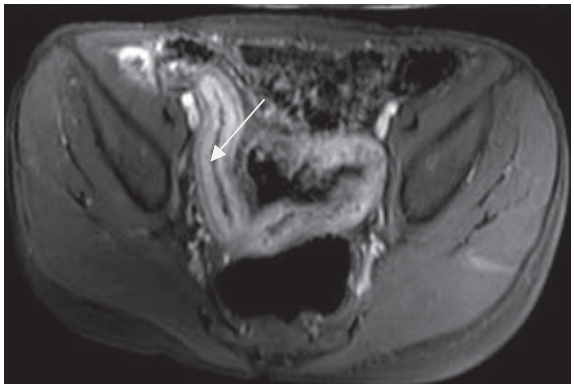
CASE 2 CROHN'S DISEASE



Axial unenhanced T1 weighted image shows long segment wall thickening of distal ileum. The involvement is transmural with surrounding fat stranding.

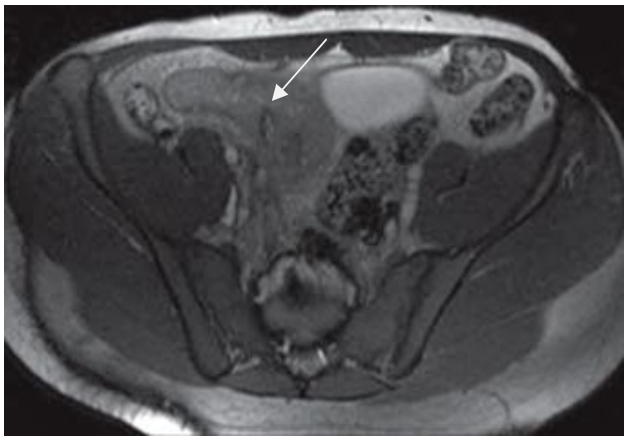


Axial T2 weighted MR shows long segment moderate ileal wall thickening with luminal narrowing. Mucosa is edematous and T2 hyperintense.

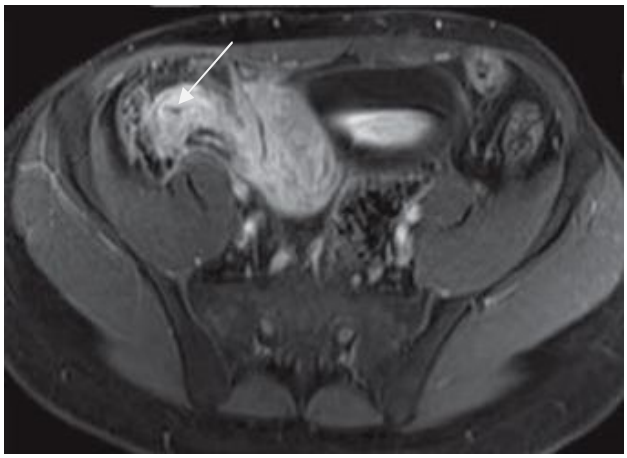


Axial T1 weighted post contrast MR shows significant contrast enhancement suggesting active disease

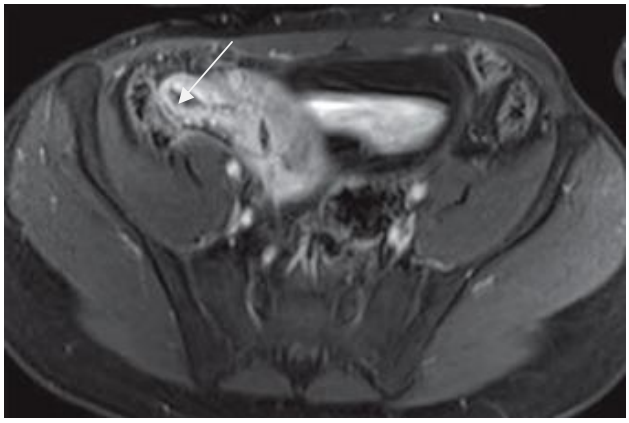
CASE 3 CROHN'S DISEASE



Axial T2 weighted MR shows conglomeration of distal ileal loops in right lower quadrant.

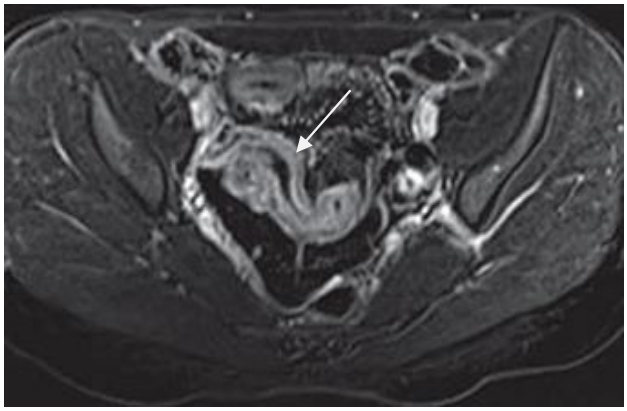


Axial T1 weighted post contrast MR shows intense contrast enhancement with surrounding fat stranding with adherence of bowel loops to the bladder wall.

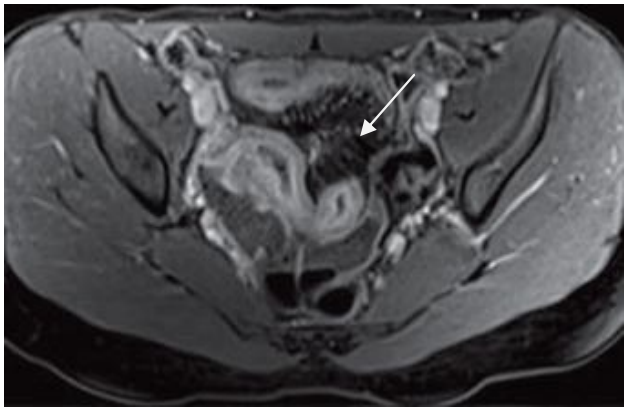


Axial T1 weighted post contrast MR shows marked luminal narrowing with combs sign suggesting active inflammation.

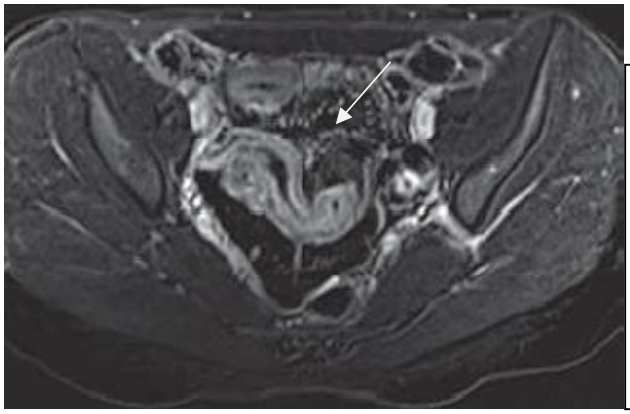
CASE 4 CROHN'S DISEASE



Axial T1 weighted post contrast subtracted MR shows multifocal ileal thickening with intense contrast enhancement and mild luminal narrowing



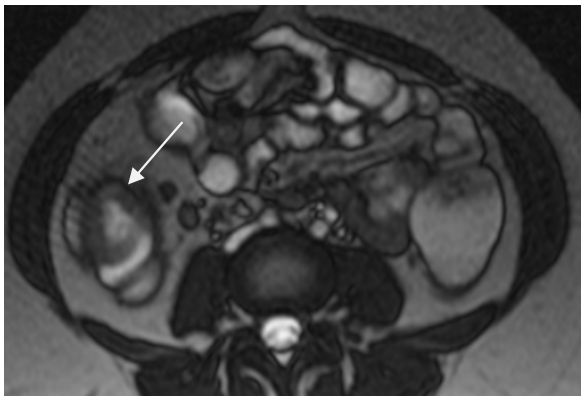
Axial T1 weighted post contrast MR shows increased fat between the bowel loops – fibrofatty proliferation

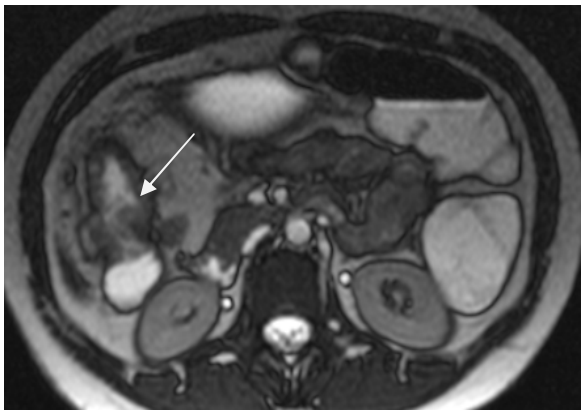


Axial T1 weighted post contrast MR shows increased mesenteric vascularity perpendicular to the bowel wall resembling teeth of the comb – combs sign suggesting active crohns disease.

CASE 5 CROHN'S DISEASE

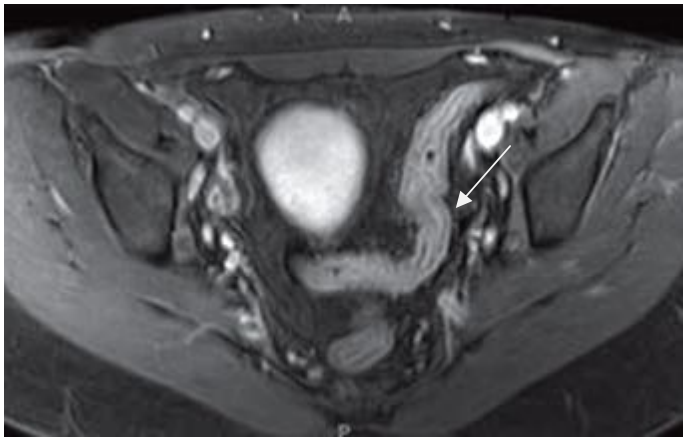
Coronal Tru Fisp image showing moderate terminal ileal and ceacal thickening with skip lesions at ascending colon at the hepatic flexure level.



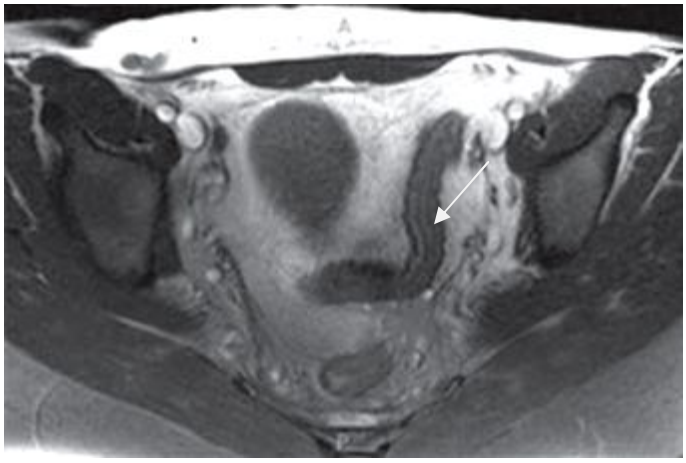


Axial Tru Fisp image showing moderate terminal ileal and ceacal thickening with skip lesions at ascending colon at the hepatic flexure level.

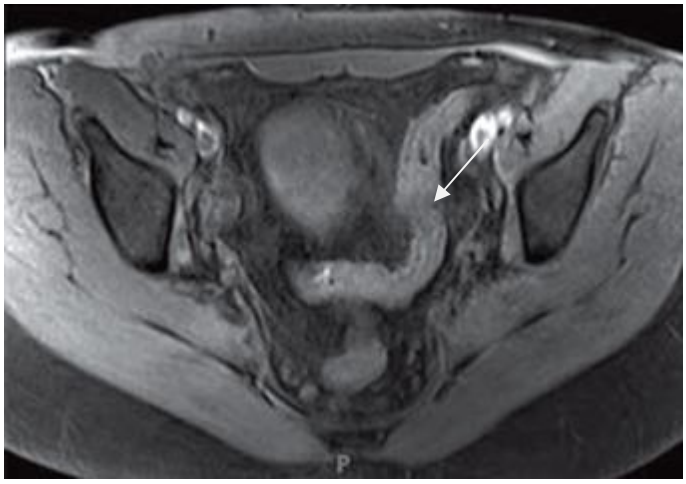
CASE 6 ULCERATIVE COLITIS



Axial Fat sat T2 weighted image showing wall thickening of sigmoid colon and T2 hyperintensity of the mucosa. Adjacent fat appears normal.

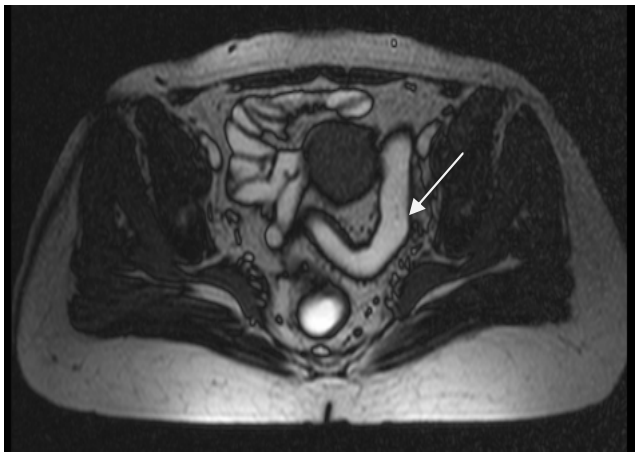


Axial T1 weighted image of the same patient shows diffuse wall thickening of the sigmoid colon .

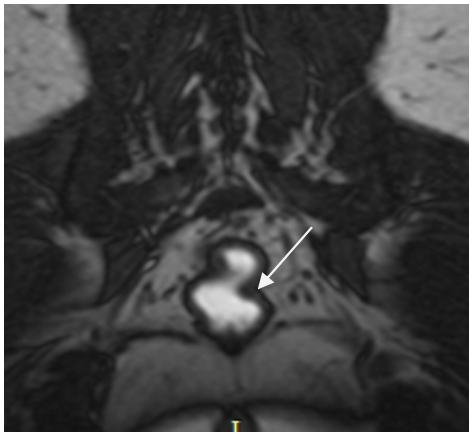


Axial contrast enhanced T1 weighted image of the same patient contrast enhancement of the inflammed mucosa. Enhancement is mainly limited to the mucosa and the surrounding fat appears normal.

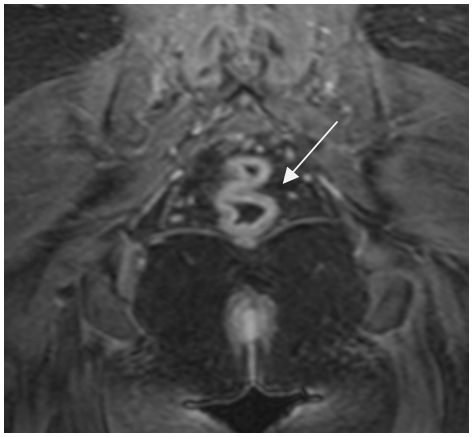
CASE 7 ULCERATIVE COLITIS



Axial Tru Fisp image showing uniform long segment wall thickening of the rectum and sigmoid colon. Wall thickening is minimal and looking like prominence of black boundary artifact.

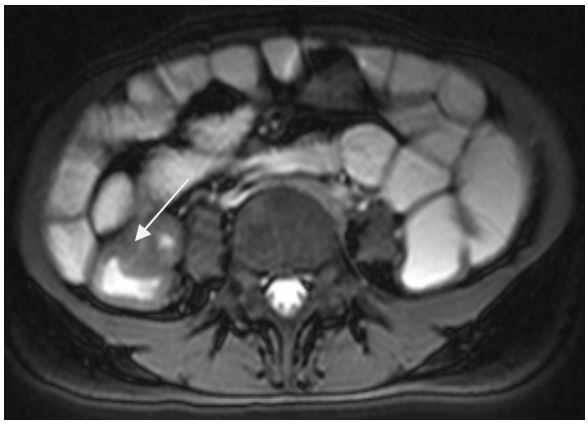


Coronal Tru Fisp image showing uniform wall thickening of the rectum with surrounding fat appears normal.

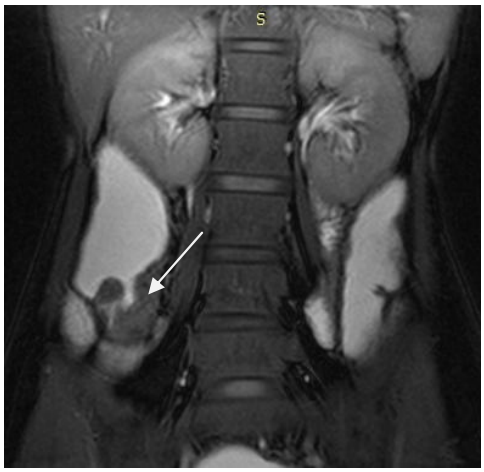


Coronal T1 contrast enhanced image showing uniform mucosal enhancement of rectal mucosa.

CASE 8 ILEO CEACAL TUBERCULOSIS



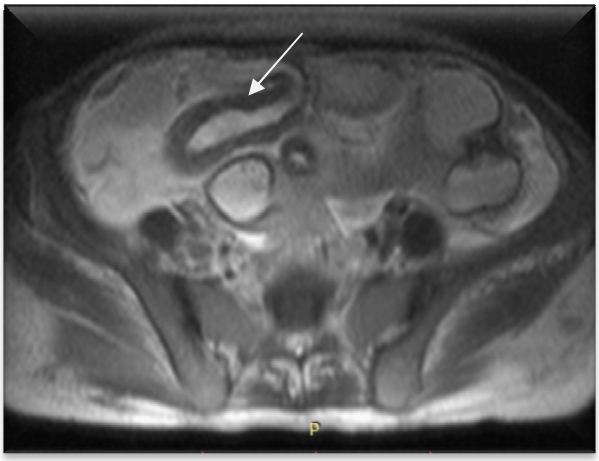
Axial TruFisp image showing moderate wall thickening of terminal ileum ileoceacal junction and ceacum



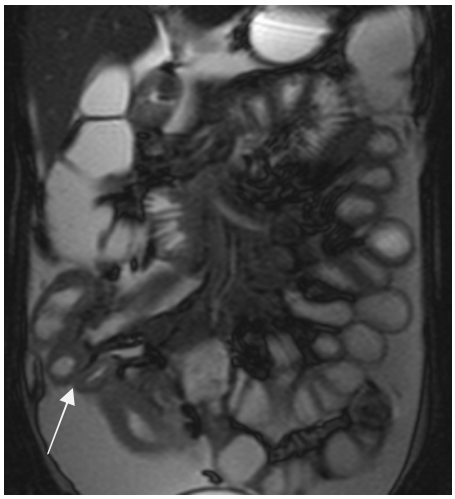
Coronal TruFisp image showing moderate wall thickening of ceacum and ileoceacal junction

Coronal contrast enhanced T1 weighted image showing mild enhancement of the bowel at ileoceacal region

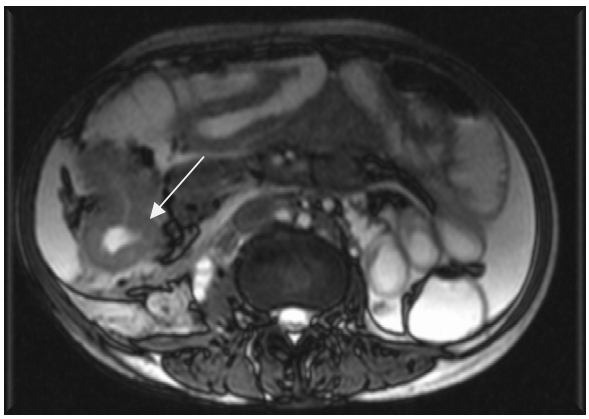
CASE 9 ILEO CEACAL TUBERCULOSIS



Axial TruFisp weighted image showing long segment circumferential wall thickening of ileal loops with ascities and few adjacent enlarged lymph nodes.

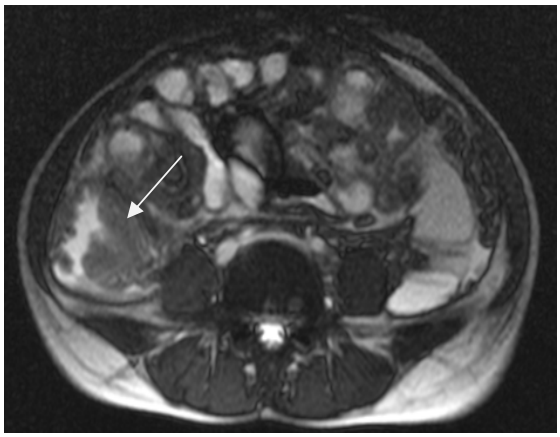


Coronal TruFisp weighted image showing long segment circumferential wall thickening of ileal loops and ceacum with ascities and enlarged mesenteric lymph nodes.

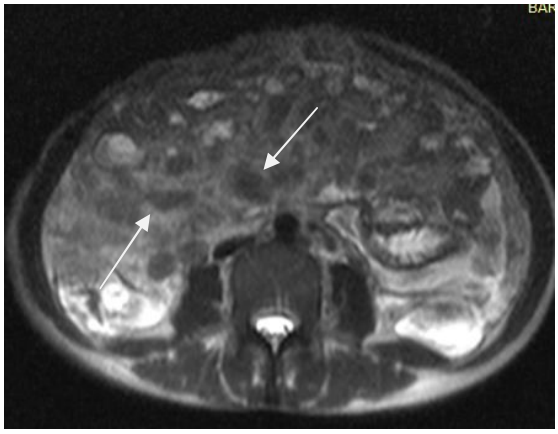


Axial TruFisp weighted image showing long segment circumferential wall thickening of ileal loops with ascities and few adjacent enlarged lymph nodes.

CASE 10 ILEO CEACAL TUBERCULOSIS



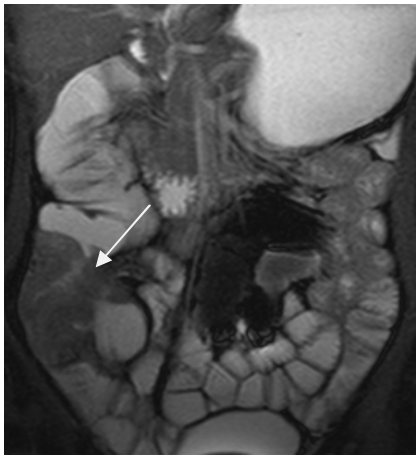
Axial TruFisp weighted image showing irregular circumferential wall thickening of ileal loops with moderate luminal narrowing with adjacent lymph nodes.



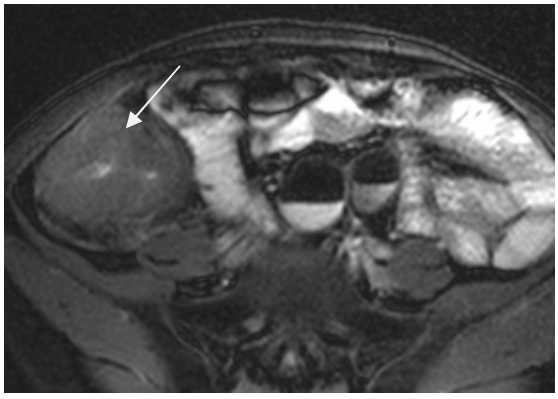
Axial TruFisp weighted image showing multiple mesenteric lymphnodes

Axial TruFisp weighted image showing ascities and incidental dermoid in left ovary

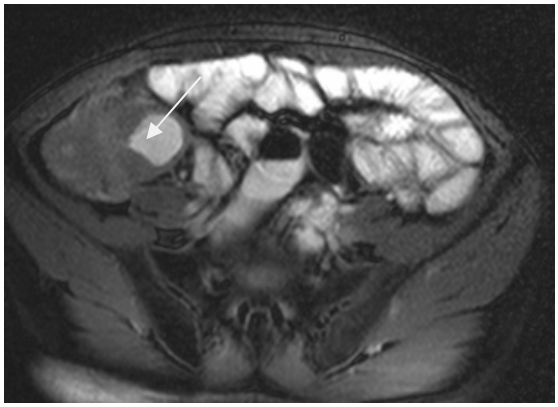
CASE 11 CEACAL GROWTH



Coronal TruFisp weighted image showing gross thickening of ceacum and ascending colon causing marked luminal narrowing.



Axial TruFisp weighted image showing gross thickening of ceacum and ascending colon causing marked luminal narrowing.

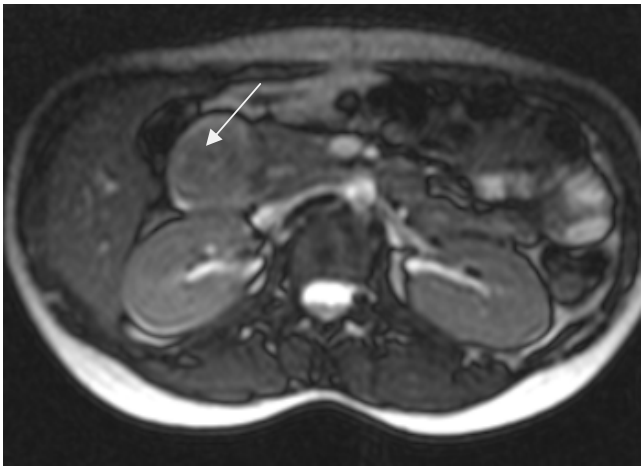


Axial TruFisp weighted image showing gross thickening of ceacum and ascending colon causing marked luminal narrowing.

CASE 12 RECTAL GROWTH

Patient who had obsure gastrointestinal bleeding shows focal asymmetrical wall thickening of rectum and on follow up with scopy and HPE came to be rectal adenocarcinoma

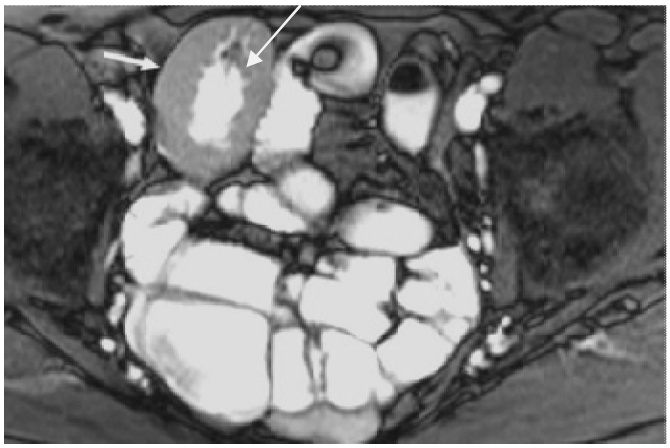
CASE 13 DUODENAL ADENOMA



Axial truFisp image showing 3.2 x 2.5 cm well defined lesion in the third part of duodenum.

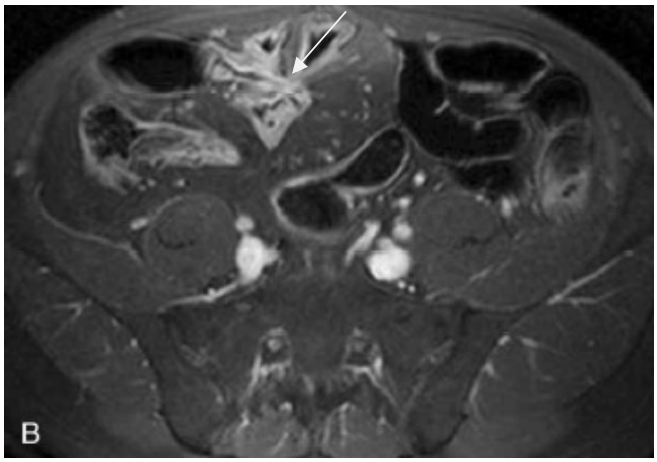
Coronal truFisp image showing the same lesion in the third part of duodenum with peripheral flow of oral contrast.

CASE 14 JEJUNAL LYMPHOMA



Axial TruFisp image showing concentric mural thickening of jejunum suggestive of jejuna lymphoma. HPE came as B cell lymphoma

CASE 15 ENTERO ENTERIC FISTULA



Patient who had apast history of bowel surgery showing adhesions and entero enteric fistula causing luminal narrowing and enhancement of the bowel wall.

MR ENTEROGRAPHY

In this study, it is shown that MR enterography is better imaging tool for small bowel visualization. The advantages of MR enterography that are emphasized in this study are superior tissue characterization, adequate distension is available in most of the patients, extramural lesions are detected better, transmural involvement is clearly shown and evaluation of disease activity also demonstrated, and importantly without using ionizing radiation.

In most of the studies in literature sensitivity and specificity of MR enterography is equal to or higher than CT enterography. The sensitivity and specificity of MR enterography in diagnosing small bowel disease in this study is 92.30% and 91.66% respectively. This value is clearly higher than sensitivity(88%) and specificity (88%) obtained by **Foriano et al (59).** The sensitivity and specificity obtained in this study is higher or equal than most of the studies in the literature.

The sensitivity for MR enterography in diagnosing crohns in this study is 77.77% and specificity of MR enterography in crohns is 97.56%.

The sensitivity is lower than overall sensitivity because two patients that was reported as normal in MR enterography was diagnosed to have crohns disease in scopy and confirmed with HPE. This may be due to the early mucosal change that are not visualized in MR enterography.

As the protocol is simple, reliable and reproducible, MR enterography will become the first line modality in future for small bowel visualization and for knowing the extent of the disease and for follow up.

MR IMAGING OF ILEOCEACAL TUBERCULOSIS

- Long segment wall thickening of ascending colon, terminal ileum with pulled up caecum, paraaortic lymphadenopathy and ascites,
- Asymmetrical wall thickening of the caecum and terminal ileum, low density lymph nodes in the paracaval, paraaortic, aortocaval region.
- Terminal ileum thickening with mesenteric inflammatory changes.

DIFFERENTIATING FEATURES OF ILEOCECAL TUBERCULOSIS AND CROHNS DISEASE:-

TUBERCULOSIS FEATURES:

- Asymmetric wall thickening, irregular,
- No creeping fat,
- Omental and peritoneal thickening,
- Enlarged lymph nodes with low-density centers.

CROHN'S DISEASE FEATURES

- Circumferential bowel wall thickening +/- mural stratification,
- Creeping fat (abnormal quantity of mesenteric fat),
- Prominent mesenteric vessels indicating hyperemia,
- Normal omentum and peritoneum

MR IMAGING OF CROHNS DISEASE

In this study it is shown that eight patients with crohns disease is diagnosed out of 50 patients with small bowel symptoms. Sensitivity obtained in this study in diagnosing crohn's is 77.77% which is lower than the studies in the literature. Specificity in this study is 97.56% which is higher than most of the studies.

Studies done by albert et al, reiber et al, umaschaden et al, Bernstein et al compared MR enterography sensitivity and specificity in diagnosing crohns disease with multiple other modalities. From these studies they have concluded that MR has excellent sensitivity and specificity for detecting active inflammation. MR is far better than conventional barium follow through and conventional enteroclysis. (28, 39, 40, 41).

Bernstein CN et al, Schmidt S et al, Rieber A et al showed that differentiating between inflammatory strictures and fibrostenotic strictures is well made out in MR enterography (28,41,42).

Gourtsoyiannis et al and Prassopoulos P et al in their study said that eventhough MRI is best in detecting mural, transmural, extraluminal disease; subtle mucosal changes cannot be picked up by MRI due to less spatial resolution. They also added that these mucosal changes are better shown in barium studies. This is considered as a significant limitation for MRI in diagnosing early stage of crohn's disease. (43, 44).

There is no enough study done so far for comparison of MR and CT enterography. Horsthuis et al (45) and Siddiki et al (46), both did a meta analysis study and showed that there is no difference in sensitivity between both modalities and both has similar accuracy in identifying and demonstrating the disease.

ACTIVE SIGNS OF CROHN'S DISEASE IN MRI

- Bowel wall thickening,
- Increased mucosal enhancement – earliest sign,
- Comb sign - increased mesenteric vascularity,
- Mucosal ulcerations,
- Perienteric inflammation,
- High signal intensity in the bowel wall in T2 sequence.
- Penetrating disease & fistulas
- Reactive lymphadenopathy
- Bowel obstruction.

Even without bowel wall thickening mucosal hyperenhancement is considered as earliest signs of active crohns. This statement is substantiated by the study done by Choi D et al and Del Vescova et al (47,48).

WALL ENHANCEMENT PATTERNS

- Uniform homogenous enhancement of bowel wall
- Stratified pattern of enhancement- mucosal enhancement with submucosal edema
- Target pattern –addition to stratified pattern serosal enhancement giving alternate hyper and hypo intense layers giving target appearance.

In this study wall enhancement is seen in all the patients diagnosed as crohn's disease. Stratified pattern is seen in one patient and target pattern is seen in one patient and remaining all has homogenous enhancement pattern.

SMALL BOWEL MASSES

Only three patients out of 50 patients enrolled in the study showed small bowel masses. There is very little studies available for role of MR imaging in small bowel masses.

One study done by Caspari r et al in 2004 compared efficacy of MRI and capsule endoscopy in the detection of polyps(51). The study mentioned no significant difference between MRI and capsule endoscopy in detecting polyps (larger size) in small intestine but MRI is superior in localisising its location in the small bowel.

Even CT can be utilized for detecting small bowel masses but contrast enhancement of masses are different. Polyps will be missed in suboptimal distension of bowel loops. Some of the mass lesions and polyps are isodense to the bowel wall hence difficult in detecting in CT.

Some polyps or masses are hyperenhancing and with oral contrast agents that are brighter in CT, lesions might be missed, these lesions are better shown in CT if neutral oral contrast is given.

In MRI biphasic oral contrast is used hence this limitation seen in CT is overcome in MRI.

SMALL BOWEL OBSTRUCTION

In our study small bowel obstruction is seen in twelve out of 26 patients with abnormalities in MR enterography. Very little data in the literature about the dedicated study of role in MRI in detecting small bowel obstruction.

Beall DP et al and Low RN et al done a study about the role of MRI in diagnosing high grade obstruction in acute condition and depicted that MRI has a very high sensitivity for detecting acute bowel obstruction and differentiating its causes (36,52).

In the case of low grade obstruction, the imaging methods are different. Routine cross sectional CT or MRI may not be able to detect the abnormalities in patients with intermittent low grade obstruction. And it is mainly because of the suboptimal distension of the bowel loops.

Many studies showed that CT or MR enteroclysis is more superior in detecting lesions in low grade bowel obstruction. Most of the cases low grade obstruction is mainly because of adhesions and focal strictures. In the CT enteroclysis or enterography the main disadvantage is unable to

differentiate between contracting bowel loop and focal wall thickening or stricture. For that repeat study or real time imaging is needed as contracting segment due to peristalsis will be reverted back to normal. But repeat CT examination will result in increase in radiation dose. MRI will be helpful in these patients and there is advent of cine MRI which readily differentiates between these two conditions.

PERIANAL CROHN'S DISEASE

In our study perianal fistulas and abscess is seen in two patients with crohn’s disease. For assessment of fistula MRI is far superior than any other modalities as it is vital to give the tracts relation with internal sphincter as it will change the treatment modality.

Unlike small bowel imaging in crohns which have a lot of debate in the superiority of the modality, MRI is accepted as the modality in imaging perianal fistula by almost everyone. Sensitivity for MRI in imaging perianal fistulas is 80% and accuracy of more than 90% (53,54).

St. James University grading for perianal fistula in MRI is widely acceptable and very well surgically correlated (55). CT scans are less useful in imaging perianal crohns as sphincter complex cannot be better depicted in CT. Another modality that can be used for imaging perianal fistula are endoscopic ultrasound.

In MRI recent addition of diffusion weighted sequence is better additive and alternative for T2 weighted and contrast sequence. Ziech, Felt-Bersma and Stoker done a study in perianal fistula and proved its validity (56).

MRI IN ULCERATIVE COLITIS:

Crohn's and ulcerative colitis both are inflammatory bowel disease. There are lots of studies in literature available in assessing efficacy and sensitivity for MRI in crohn's disease. But only very few studies available for assessing efficacy of MRI in ulcerative colitis. This condition arise because of the basic difference between ulcerative colitis and crohn's disease.

More than 95% of ulcerative colitis involves mainly the rectum and usually follows the predictable course from left side of colon then

transverse and right side of colon. But in crohn's any part of the bowel can be involved and has highly unpredictable and discontinuous course.

In ulcerative colitis distal ileum is involved only in the consequence of pancolitis, isolated ileal involvement not occurs with ulcerative colitis

In crohn's disease the main area of involvement is mucosal inflammation of distal ileum. Ulcerative colitis is mainly mucosal disease, extramural inflammation is usually not seen in this disease. Perienteric fats are normal in ulcerative colitis.

SIGNS OF ULCERATIVE COLITIS ARE:

- Mild to moderate bowel wall thickening
- Loss of haustrations
- Presacral space widening.

COMPLICATIONS OF ULCERATIVE COLITIS:

- Toxic megacolon
- Stricture
- Massive bleeding
- Colorectal cancer

- Perianal complications, abscess, fistulas not usually seen in ulcerative colitis.

Diagnosing crohn's is more tough than diagnosing ulcerative colitis. In this study two patients showed features of ulcerative colitis which shows uniform thickening of bowel wall with contrast enhancement with fat around the lesion appears normal. Thus it is a mucosal disease with predominant rectal involvement so endoscopy and biopsy is easier with ulcerative colitis as it mainly involves the colon and small bowel is rarely involved. Hence cross sectional imaging is not playing major role in diagnosing ulcerative colitis.

But in crohn's it is a transmural disease with mainly small bowel involvement and with many complications , so cross sectional imaging plays an important role in crohn's disease.

Eventhough ulcerative colitis is better diagnosed with scopy, there are conditions like where MRI is a very good alternative for endoscopy .

- Contraindications for endoscopy
- High morbidity for the procedure
- Refusal by the patients
- Incomplete endoscopic procedure

CONCLUSION

MR enterography is of major benefit and problem solving diagnostic modality in patients with suspected small bowel disease.

Especially young patients with chronic small bowel symptoms, MR enterography is modality of choice as it has no radiation.

In this study it is well made out that study protocol is simple and acceptable and patient's compliance to the study is far better.

MR enterography can be used as a screening tool for diagnosing small bowel disease as most of the patients are refusing invasive procedures as a screening modality.

In this MR enterography various manifestations of crohn's disease and intestinal tuberculosis is seen and it is used as a primary tool to evaluate presence of the disease and also the extent of the disease.

In cases where colonoscopy did not reach the terminal ileum, MR enterography may help to determine the optimal therapeutic strategy.

Disease activity can be predicted by MR enterography by looking at bowel edema and contrast enhancement of bowel wall and lymph nodes.

In this study various small bowel diseases are detected and some of the large bowel diseases that presents with small bowel symptoms also found out. The range of indications for MR enterography became wide and also including small bowel obstruction, motility disorders, persistent diarrhea and abdominal pain, and a problem solving tool when other imaging modalities cannot diagnose a small bowel abnormality.

Thus, MR enterography is an excellent modality that has adequate transmural visualization of the small bowel and providing sufficient information about etiology, distribution, exact location, activity of the disease, and complications of the disease. Thus, MR enterography will be the method of choice for the noninvasive evaluation of small bowel disorders.

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PATIENT CONSENT FORM

ROLE OF MR ENTEROGRAPHY IN SMALL BOWEL DISEASES

Institution : **Barnard Institute of Radio Diagnosis,**
Madras Medical College,
Chennai-600 003.

Name	:	Date	:
Age	:	IP No	:
Sex	:	Project Patient No	:

The details of the study have been provided to me in writing and explained to me in my own language.

I confirm that I have understood the above study and had the opportunity to ask questions.

I understood that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without the medical care that will normally be provided by the hospital being affected.

I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).

I have been given an information sheet giving details of the study.

I fully consent to participate in the above study **Role Of MR Enterography In Small Bowel Diseases**.

Name of the Subject	Signature	Date

PROFORMA

Name:

Age and sex:

IP/ OP number:

Ward number:

Address:

Contact number:

HISTORY:

1. Diarrhea with duration
2. Blood in stools
3. Abdominal pain
4. Fever
5. Vomiting
6. Previous investigations
7. Any drug allergy

PAST HISTORY:

INVESTIGATION:

1. Ultrasound abdomen
2. Upper GI endoscopy findings if any
3. Lower GI endoscopy findings if any
4. Serum creatinine
5. Blood urea
6. Hemoglobin
7. ESR

MR ENTEROGRPAHY FINDINGS:

FOLLOW UP:

HPE FINDINGS:

MASTER CHART

S. NO	NAME	AGE/ SEX	CLINICAL HISTORY	MR ENTEROGRPAHY FINDINGS	FOLLOW UP WITH HPE
1	Anjalai	35/F	Weight loss, lower abdominal pain, diarrhea for past one month	Long segment ileoceacal thickening with ascities with multiple mesenteric node enlargement s/o ileoceacal tuberculosis	Tuberculosis
2	Perumal	37/M	Lower adominal pain with CT showing subtle wall thickening in ileal loops	Normal	Normal
3	Lakshmipathy	42/M	Abdominal pain and distension ? subacute intestinal obstruction	Normal	Normal
4	Prakash	44/M	Unknown cause of lower gi bleeding	Skip lesions with bowel mucosal enhancement - Crohn’s disease	Crohn’s disease
5	Balashankar	35/M	Lower abdominal pain	Irregular distal ileal thickening with surrounding fat stranding- Tuberculosis	Tuberculosis
6	Balaji	18/M	Chronic lower abdominal pain	Normal	Normal
7	Pradeepa	32/F	Lower abdominal pain	Bowel wall thickening in ileum , colon with perianal fistula Crohn’s disease	Crohn’s disease
8	Xavier	37/M	Abdominal pain and vomiting for 2 months	Normal	Normal
9	Lakshmanan	18/M	Multiple perianal fistula	Crohn’s disease and multiple fistula in ano and perianal abscess	Crohn’s disease
10	Nagammal	26/F	Abdominal distension and pain for 3 months	Gross ileum and ceacal thickening with ascities and multiple mesenteric nodes and incidental dermoid in left ovary- Tuberculosis	Tuberculosis
11	Vishnu priya	39/F	History of small	Entero enteric	Entero enteric

			bowel surgery for vasculitis and segmental gangrene of small bowel	Fistula	Fistula
12	Murugaiyan	50/M	Bleeding P/R for 3 months with colonoscopy normal	Mild asymmetrical thickening noted in the rectum- rectal growth	Repeat colonoscopy confirmed the findings- HPE- Adenocarcinoma
13	Krishnaveni	50/F	Chronic right ilac fossa pain with diarrhea ?intestinal tuberculosis	Normal	Normal
14	Nirmala	35/F	?subacute intestinal obstruction	Normal	Normal
15	Sathya	21/F	Vague abdominal pain	Well defined T2 hyperintense lesion in the third part of duodenum- Small bowel neoplasm	HPE- Duodenal adenoma
16	Rajesh	33/M	Chronic abdominal pain	Asymmetrical wall thickening of terminal ileum and ceacum- Tuberculosis	Tuberculosis
17	Paranthaman	36/M	Frequent diarrhea more than 4 times per month ?infectious enteritis	Normal	Normal
18	Jayalakshmi	35/F	Diarrhea on and off for 2 months with bleeding P/R	Normal	Normal
19	Kannan	35/M	Multiple perianal fistula ? crohn's disease	Normal	Normal
20	Anitha	22/F	Chronic diarrhea	Smooth bowel wall thickening with skip lesions	Crohn's disease
21	Prakash	55/M	? subacute intestinal obstruction	Target pattern of bowel enhancement- Crohn's disease	Crohn's disease
22	Gowri	50/F	Past history of appendicectomy with chronic right iliac fossa pain ? tuberculosis	Normal	Normal
23	Sundarammal	52/F	?low grade small bowel obstruction	Normal	Normal
24	Nagalingam	27/M	? inflammatory bowel disease	Terminal ileal thickening with mucosal edema	Crohn's disease
25	Kuppu gownder	40/M	Altered bowel habits for one month	Normal	Normal

26	Shanthi	25/F	Abdominal pain and constipation for one month	Normal	Normal
27	Venkatesan	33/M	Diarrhea on and off for 2 months	Bowel wall thickening with homogenously enhancing terminal ileum with skip lesions Crohn's disease	HPE- nonspecific enteritis
28	Susan	30/F	Anal fistula for evaluation	Crohn's disease	Crohn's disease
29	Muthupandi	36/M	?subacute intestinal obstruction	Normal	Normal
30	Sami	44/M	Abdominal pain on and off	Crohn's disease	Crohn's disease
31	Krishnan	29/M	Lower abdominal pain and diarrhea for past 2 months	Normal	Mucosal edema in terminal ileum HPE- crohn's
32	Punitha	36/F	Bloody diarrhea for 1 month	Stratified contrast enhancement of ileum - Crohn's disease	Crohn's disease
33	shini	33/F	Diarrhea on and off for 3 months	Normal	Normal
34	Veda vidya	26/F	Altered bowel habits ? inflammatory bowel disease	Normal	Normal
35	Lakshmi	70/F	Vague lower abdominal pain for 3 months	Subtle thickening of terminal ileum and ileo ceacal junction- tuberculosis	Tuberculosis
36	Rajkumar	37/M	Abdominal pain for 2 months ? inflammatory bowel disease	Gross irregular circumferential wall thickening in ceacum. Terminal ileum appears normal- Ceacal growth	HPE – Ceacal adenocarcinoma
37	Balakumaran	35/M	Ultrasound abdomen showing wall thickening in right ilac fossa	Normal	Normal
38	Munij	14/M	Fever, unexplained weight loss	Ileoceacal thickening - tuberculosis	Tuberculosis
39	Vijayasekaran	50/M	?intestinal tuberculosis	Normal	Normal
40	Elangovan	55/M	Abdominal pain , vomiting for 1 month	Ileoceacl thickening for a length of 5 cm tuberculosis	Tuberculosis

41	Vidhya	32/F	Chronic diarrhea	Suspicious thickening of ileocecal junction-Inconclusive	Inconclusie scopy and HPE findings. Case on follow up.
42	Venkata prasanna	30/M	?inflammatory bowel disease	Normal	Normal
43	Nazeema begum	36/F	Bloody diarrhea for 3 months evaluated for that in private hospital ? ulcerative colitis	Rectal circumferential wall thickening with contrast enhancement Ulcerative Colitis	Ulcerative Colitis
44	Shameem Taj	29/F	Evaluated for arthritic pain and bilateral sacroilitis	Circumferntial rectal wall thickening with contrast enhancement - Ulcerative Colitis	Ulcerative Colitis
45	Surya	20/F	Lower abdominal pain for 4 months on and off	Normal	Mucosal thickening in distal ileum with mucosal edemal – HPE-Crohn's
46	Patchaiammal	22/F	Diarhoea on and off with lower gi bleeding	Subtle thickening at ileoceacal junction-Tuberculosis	Tuberculosis
47	Parvatham	46/F	Diarrhea on and off with bleeding P/R	Normal	Normal
48	Paremeshwar	30/M	Abdominal pain on and off	Carcioid tumour distal ileum	Patient underwent surgey HPE-carcinoid
49	Krishna Kumar	30/M	Non specific abdominal pain with diarrhea	Normal	Normal
50	Selvam	42/M	Right lower quadrant pain	Normal	Normal